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Nº 134

South African Air Force Standard Notes

ARMAMENT

CHAPTER I
SECTION "G"

HISTORICAL INTRODUCTION TO GUNNERY

Printed in the Union of South Africa by the Government Printer, Pretoria.
1939
G.P.-S.11841—1939—1,000.

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SECTION " G ".

GUNNERY SUBJECTS.

PRÉCIS—INDEX.

Chapter I: Historical Introduction of Gunnery Subjects.

,, II: Theory of Aerial Sighting—Camera Guns and Gun Mountings.

,, III: Interrupter Gear—Pneumatic and Hydraulic Gears.

,, IV: Vickers Gun ·303″ Aircooled Mk. V.

,, V: Vickers Gun ·303″ (Gas Operated) Mk. I " K ".

,, VI: Browning Gun ·303″ (Recoil).

,, VII: Armament Maintenance Orders.

ARMAMENT.

SECTION "G".

CHAPTER I.

"A"—INTRODUCTORY HISTORICAL LECTURE ON INTERRUPTER GEAR, FIXED AND FREE GUNS.

Early Developments.

Before the 1914-1918 War certain experiments were undertaken, chiefly in France, in arming aeroplanes with machine guns. During the first four months of aerial warfare, however, carbines, shot-guns, pistols and hand grenades were used. Also various objects were attached to cables with the idea of fouling the propellors of enemy machines; but it was soon realised that the only successful weapon in air combat was the machine gun.

NOTE.—Machine guns fitted to aircraft are of two classes today, fixed and free. The type to be dealt with first, are fixed guns, essentially a pilot's weapon, which may be defined as guns mounted on an aircraft to fire only forward in the line of flight of the aircraft and aimed by manoeuvring the machine to which they are fitted.

Three months after the outbreak of the war a Lewis gun (ground service model), magazine 47 rounds, was fitted to British aircraft. As a free and fixed gun this was mounted on the upper main plane just above the centre section and in certain cases on the sides of certain war-time tractor aircraft, notably the B.E. series. These guns pointed out at an angle to the line of flight in order that their bullets could clear the air-screw. This meant the pilot had to manoeuvre his machine in one direction and fire in another.

Though this step proved to be a great improvement, serious disadvantages soon became apparent. Magazines were too small and this led to the introduction of a 97-round magazine. Having to fire at an angle to the flight

path of the aircraft with fixed guns in order to obviate hitting your own propellor, was also a serious disadvantage and this made sighting so complicated that luck played a large part in obtaining a hit. The necessity for some appliance or interrupter gear which would make firing through the plane of rotation of the airscrew, parallel to the flight path of the aircraft possible, therefore became apparent.

In 1915, Garras, a French Ace, used the first "Deflector Plates" which partially solved this problem and enabled him to fire through the plane of rotation of the airscrew, with some measure of success. These steel plates were fitted to the airscrew and served to deflect from the propellor any rounds fired from an unsynchronised gun which would otherwise have struck and pierced it.

The Germans soon captured a French machine and discovered the metal deflecting plates on the blades of the propellor. This propellor was passed to Anthony Fokker, a Dutchman, and in a few days he evolved the first safe and practicable interrupter gear to be used on aeroplanes in the war. An ordinary Parabellum gun firing at 400 rounds per minute was used, and in 1916 the German Albatros D.1. appeared with one fixed synchronised gun and later with two guns firing forward. During this period Vickers were also experimenting with mechanical interrupter gears and during 1915 some Bristol single seaters were sent to France fitted with this mechanism. Several other makes were also tried, but it was not until 1917, that the British synchronising gear was superior to that of Germany. To Georges Constantinesco, a Rumanian, who had been experimenting with the transmission of power by waves, credit is due for the ultimate superiority of the British Gear. The first demonstration of his gear was given in August, 1916, on a B.E. areoplane, and thereafter the gear was fitted to allied aircraft as quickly as possible. The modern version of this gear is fitted to the Wapiti, Hart and Hartbees aircraft.

This new method of firing and mounting fixed guns made the use of heavier and faster guns possible and Vickers guns were introduced in the Service, the first being a Mk. I. This was a ground gun of which the water jacket had been louvered and pierced to allow a free passage of air over the barrel and so efficient cooling was obtained. The rate of fire was thus increased and

there was no delay caused in changing pans, etc., as the gun was belt fed. The gun was continually improved on and today the Mk. V. has been introduced in the Service, which has a 50 per cent. increased rate of fire and is almost stoppage free.

Though the Fokker and Constantinesco Interrupter Gears solved the problem of fixed guns firing through the plane of rotation of the propellor with perfect safety, these devices have always had the inherent weakness in that the continuous firing of the guns are being constantly interrupted to prevent the bullets from piercing the propellor, thus preventing the guns from developing their maximum rate of fire. In recent years advances in aircraft design and structural strength have made the placing of guns outside the plane of rotation of the airscrew possible. The interrupter gear thus becomes unnecessary, and in aircraft such as the Hawker Hurricane, Spitfire, etc., it has been done away with. These modern fighters have eight guns firing forward—four in each wing, giving a lethal zone of fire of approximately 12 ft. in diameter at 200 yards range, each gun firing at a rate of approximately 1,200 rounds per minute. Mk. V. Vickers Guns and modified Browning Guns are being used for this purpose. They are controlled pneumatically but present development seems to indicate that a hydraulically operated control working on the same principle as the interrupter gear will eventually prove the most satisfactory.

Free Guns.

Description.—Free guns as they are known today came into use with two and multi-seater aircraft about the same time as fixed guns were being fitted to fighter aircraft. A free gun is today essentially an observer's or rear gunner's weapon. It is fitted to fire in any direction; its chief function being to protect the aircraft from enemy attacks from above, below and behind.

Like fixed guns, these guns were developed from a "land" type. The belts of a belt-fed gun were apt to cause an obstruction to a gunner operating a movable mounting, so the Lewis drum-fed pattern was chosen during the war as the standard movable gun, for use in the R.A.F. The large barrel casing carrying the cooling fins, was dispensed with since it was found that the airstream cooled the gun sufficiently. Ninety-seven-round drums were used and the rate of fire was about

700 rounds per minute. Lewis guns are today being replaced by Vickers gas-operated " K " guns, which are mounted singly or in pairs in hydraulically operated turrets or on modified Scarf rings. The drum type of feed is still retained although experiments are being conducted in an attempt to evolve a more satisfactory method.

Browning and Vickers guns mounted in turrets are also being experimented with. Mounted in pairs and in some cases in fours, they retain their belt feed advantages.

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CHAPTER II

Theory of Aerial Sighting

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ARMAMENT.

SECTION "G".

CHAPTER II.

THEORY OF AERIAL SIGHTING.

INSTRUCTIONAL EQUIPMENT.

1. Front Gun Ring and Bead Sight.(*)
2. Aldis Tube Sight.(*)
3. Norman Vane Sight (100-200 m.p.h.) and Free Gun Ring Sight.(*)
4. Camera Gun (G. 3) Complete.(*)
5. Camera Gun Films.(*)
6. Model Aircraft for C.G. Practices.(†)
7. Mk. 2 Scarff Ring Mounted on Wooden Stand to take a Camera Gun.(*)
8. Mk. VII Scarff Ring, Loose or Fitted.
9. Aircraft with Guns Fitted for Practical Lectures in Harmonization.
10. Aiming Mark Board for Harmonization.(†)
11. Mirror's Bore Barrel Reflecting.(*)

THEORY OF AERIAL SIGHTING.

NUMBER OF LECTURES: 20 (45 minutes each).

Divided as follows:—

Theory of Aerial Sighting:—		
(i) Fixed Guns	4	Lectures.
(ii) Free Guns	3	,,
Modern Sights	1	,,
Harmonization	2	,,
Practical Harmonization	1	,,
Camera Gun	2	,,
Practical and Marking Films	3	,,
Gun Mountings	1	,,
Practical on Mountings	1	,,
Revision	2	,,

(*) Obtainable from A. & A. Depot.
(†) To be manufactured locally.

SYLLABUS.

A thorough basic knowledge of:—

Fixed Guns.

(*a*) The theory of sighting—including the principle of deflection.

(*b*) The principle of the Ring Sight as developed from the Spherical Principle.

(*c*) Numerical Examples.

(*d*) Description and use of fixed gun sights.

[NOTE.—(*a*), (*b*), (*c*) and (*d*) are contained in:—
A.P. 1242, Chapter 10 as follows:—
(*a*) Paragraphs 3—8.
(*b*) Paragraphs 9—16.
(*c*) Paragraph 23.
(*d*) Paragraphs 20, 22, 24—26, 68—75.]

Free Guns.

(*a*) The principle of the Norman Vane Sight.

(*b*) Numerical Examples.

(*c*) Description and Use of Free Gun Sights.

[NOTE.—(*a*)—(*c*) contained in A.P. 1242, Part I, Chapter 10, as follows:—
(*a*) Paragraphs 27—35.
(*b*) Paragraph 34.
(*c*) Paragraphs 76—79.]

Modern Sights.

Introduction and description of Reflector Sights. The principal use and description of Relative Speed Sights.

Harmonization.

Methods of harmonization for both:—
(*a*) Fixed Guns, and
(*b*) Free Guns.

Practical application of the above.

[NOTE.—(*a*) and (*b*) contained in A.P. 1242, Part I, Chapter 10, as follows:—
(*a*) Paragraphs 36—42.
(*b*) Paragraphs 36—40, 43—44.]

Commanders. In aerial gunnery everything depends on the pilot, and therefore a good gunner is a rare specimen and must be an expert in judging distance.

(iv) Ground gunnery usually allows time for preparation, whereas in air gunnery opportunities are sudden and brief, and obviously more difficult to take advantage of. The type of shooting on the ground that gives the nearest approach to these conditions is that carried out with a shot-gun against game.

3. Definitions (give sketches where possible).

(i) *Muzzle Velocity* is the velocity imparted to a projectile by the propellant gases produced from the cordite or other powder used. It is usually measured in feet per second.

(ii) *Line of Sight* is the straight line from the firer's eye through the sights to the point aimed at.

(iii) *Fixed Guns* are those which are mounted rigidly in an aeroplane so that no independent elevating or traversing movement is possible. The gun is fixed so that it fires straight forward along the line of flight of the aeroplane. In order to lay the gun it is necessary to manoeuvre the aircraft till it is flying in the direction in which the gunner wishes to fire.

(iv) *Free Guns* are those which are so mounted on the aircraft that the line of fire relative to the gunner's aircraft may be varied at the will of the gunner.

(v) *Own Speed* is the speed in miles per hour of the aeroplane carrying the gun.

(vi) *Target Speed* is the speed in miles per hour of the aeroplane to be fired at.

(vii) *Angle of Deflection* is the angle between the line of sight and a line drawn parallel to the axis of the barrel from any point of the line of sight.

(viii) *Deflection* is the distance moved by the target aircraft during the time of flight of the projectile.

(ix) *The Point of Intersection* is the place where the bullet and the target meet.

(x) *Point of Harmonization* is that point at which the line of sight intersects the trajectory under certain specified conditions.

(xi) *Trajectory* is the actual path of flight of the bullet.

(xii) *Cone of Fire* is that portion of space which contains the trajectories of all the bullets fired.

(xiii) *Axis of the Barrel* is an imaginary line following the centre of the barrel from the breech to the muzzle.

(xiv) *Line of Departure* is the tangent to the trajectory at the gun muzzle. It may be the axis of the barrel produced, but normally it makes an angle with it.

(xv) *Jump.*—When a weapon is fired, a vibratory or wave-like motion is set up in the barrel and at the moment the bullet leaves the bore, the muzzle is usually deviated from its original axis, both vertically and laterally. This deviation is known as "Jump".

4. General Remarks and Synopsis.

(i) The path of a bullet fired from an aircraft in flight is affected by:—

(*a*) The muzzle velocity.

(*b*) Velocity of the aircraft, from which fired.

(*c*) Air resistance (neglected).

(*d*) Gravity (neglected under 200 yards).

(ii) The two main groups of aerial sights are:—

(*a*) Those suitable for fixed guns.

(*b*) Those suitable for free guns.

In fixed guns the correction necessary for the initial velocity given to the bullet by an aircraft is permanently incorporated in the sight, and a ring sight is used to allow for the target's angle and speed of approach.

In free guns it is necessary to allow for the initial velocity (gunner's own speed). A sight which allows for this speed has been designed and is known as the Norman Vane Sight. It is used in conjunction with the ring sight which in turn allows for the target's speed and angle of approach.

(iii) The speed of the target aircraft is estimated from a knowledge of the type and its capabilities. Angle of approach and speed is combined mentally and the target is then positioned in the sights accordingly.

FIXED GUN SIGHTS.

(RING SIGHT.)

5. Fixed Gun Sights (Ring Sight).

The fixed gun is so arranged that it fires along or parallel to the flight-path of the aircraft, and to lay the gun it is necessary to manoeuvre the aircraft on to the target at which the gunner is to fire. These guns are operated by the pilot and fire through the plane of rotation of the airscrew, the bullets not striking the airscrew because of the interrupter gear which controls the firing of the guns. Here the firer uses the same principles as when firing on the ground. A ring sight is used to allow for the target's angle and speed of approach.

6. Aspects of the Target.

(i) The target presents itself in the following aspects:

(*a*) Flying directly towards or directly away from the pilot.

(*b*) Flying so that its line of flight makes an angle with the gunner's line of flight.

[Drawing for (*a*) and (*b*).]

(ii) In (i) (*a*) pilot takes a direct aim.

(iii) In (i) (*b*) the angles of approach are infinite in number, and therefore for every angle of approach a different aim will be required. However great may be the variation in actual sighting the underlying principles will always remain the same.

The path of the target aircraft must intersect the gunner's line of fire, and if a correct aim is taken the path of the bullet and the path of the target aircraft will intersect at some point ahead of the target, and if the aim is to be successful, bullet and target should arrive at the same point (point of intersection) simultaneously.

7. Principle of Deflection.

Under (i) (*b*) above a direct aim will be useless, as by the time the bullet arrives on the path of flight of the target, the target will have moved along its path a distance (airspeed of the aircraft and the time of flight of the bullet), i.e. the bullet will arrive too late.

Therefore the pilot must:—

(i) Lay his guns so that the trajectory of the bullets will be ahead of the target aircraft, i.e. target aircraft must fly towards this trajectory.

(ii) Lay his guns so that bullet and target arrive at the same point at the same moment.

[NOTE.—This means that at the moment of firing there is an angle between the pilot's line of sight and the axis of the barrel. Known as angle of deflection. Amount of deflection, i.e. distance moved by target during time of flight of bullet depends on range, the average velocity of bullet, and the speed of target aircraft.]

8. Necessity for Special Sights.

The object of aircraft sighting is therefore to find the correct deflection for any particular relative target position. What is required is a simple sight that will automatically inform the pilot what angle of deflection to use for any line of approach by the target aircraft.

LECTURE No. 2.

9. Data required for a Deflection Sight.

(i) (Standard):—

(*a*) Speed of gunner's aircraft (120 m.p.h.).

(*b*) Speed of target aircraft (100 m.p.h.).

(*c*) Some range on which the calculations may be based (200 yards).

(*d*) Time of flight of bullet over range.

Assuming conditions (*a*) and (*c*) to be true,

$$\text{Time of flight} = \frac{\text{Range in feet.}}{\text{Average vel. in ft/sec.}}$$

Since in the fixed gun sight "own speed" is to be incorporated,

Average velocity.....Velocity of bullet over range + initial velocity of bullet imparted to it by the aircraft.

.....(2186 plus 176) ft. per sec.

$$\text{Time of flight} = \frac{600}{2362} = .254 \text{ secs.}$$

(ii) (*a*) and (*b*) above cannot be stated exactly as the speed of different types of aircraft vary considerably, and the speed of any one aeroplane varies according to the conditions under which it is moving. As will be seen later, this variability of speed of (*a*) does not materially affect the results for practical purposes.

(iii) The speed of the target aircraft is a much more important factor and is even more variable if the variety of aircraft that can be engaged in combat is considered. It is usual, therefore, to establish a standard of reference by assuming the target aircraft has a speed of 100 m.p.h., due allowance being made on the sight designed for this speed if any other speeds are actually met with.

(iv) The range on which the calculations should be based will depend at any given instance on the distance of the target aircraft from the firer, but as the maximum useful flat range for a ·303 calibre bullet only varies from 200-300 yards, a figure of 200 yards is used in all calculations when sights are being designed for this calibre bullet.

(v) Time of flight of bullet varies with (i) (*a*) and (i) (*c*) above.

10. Deflection Sight to allow for Targets Movement.

Amount of Deflection.—If a bullet takes ·254 seconds to reach the point of intersection the target must be same " time distance " from the intersection to enable the bullet and target to meet. The distance traversed by target in ·254 seconds is equal to the speed of target times the time of flight of bullet over the range, i.e. (147 × ·254) feet = 37·3 feet. The target must therefore be 37·3 feet from the point of intersection when the gun is fired at a range of 200 yards.

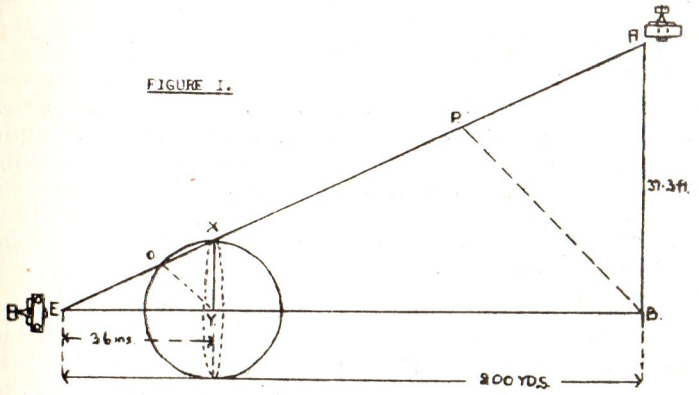
It must be noted that the target can approach from any direction, therefore it is only necessary to find some means of measuring the 37·3 feet deflection for any angle of approach. This is done by placing a suitable sighting device some convenient distance from gunner's eye to guide his line of sight into space to the correct point of aim.

11. Development and Principles of Fixed Gun Sights.

The development of such a sight can best be shown by taking a number of possible correct lines of sight for

different angles of attack and combining them. In each case the range is taken as 200 yards, target speed 100 m.p.h. and gunner's speed 120 m.p.h.

FIGURE 1.



12. Target Flying across Gunner's Front at Right Angles.

(i) On same plane.

Not to scale:—

Sight base—Deflection.

Diagram shows:—

" EB "—Direction of flight of gunner.

" E "—Gunner's eye.

" A "—Point of aim at moment of firing.

" B "—Point where gunner's line of fire and target's line of flight intersect.

" EA "—Line of sight at firing moment.

" XY "—A bar placed 36 inches from gunner's eye parallel to target's line of flight. This bar is so positioned that a straight line from " E " touching the end of the bar cuts enemy's line of flight at " A ".

" AB "—Direction of flight of enemy aircraft.

Simple mathematical proportion shows that this line XY to be 2·24 inch long if AB = 37·3 feet. By this means the gunner is given a guide to carry his line of sight to a point 37·3 feet from " B " on the target's line of flight, i.e. the gunner has the correct deflection for a target crossing his front at right angles on the

same plane. A bar on the opposite side would provide correct deflection for a target aircraft flying from the opposite side in the same plane.

(ii) In any other direction at right angles to line of flight of gunner:

If the target is climbing or diving at right angles across the gunner's line of flight the same principle holds good. A deflection of 37·3 feet is required, and if a bar of 2·24 inches is placed 36 inches from the firer's eye and parallel to the line of flight of the target aircraft, this would again give a line of sight to the correct point of aim.

In this way an infinite number of bars could be set out for sighting purposes to allow for any such possible lines of flight of a target. A circle (2·24 inches radius) placed at right angles and on the line of flight of the gunner at the point "Y" can, however, be used to replace these bars and will also satisfy the conditions of sighting required for any such attack.

13. Target Aeroplane Flying Across Gunner's Front at Angles other than at Right Angles.

(i) On same plane (Direction of Flight Target A/C = PB).

Here, too, the point of aim will always be 37·3 feet from the point of intersection at the moment of firing, and a bar OY (2·24 inches) placed 36 inches from the gunner's eye and parallel to the target's line of flight will guide the gunner's eye to the proper point of aim. If a sufficient number of examples are taken of target aircraft flying in this plane, a ring similar to the ring mentioned above, but in a plane at right angles to it would satisfy all these conditions.

(ii) On any other plane:

If the target is climbing or diving across gunner's line of flight at angles other than right angles and in planes other than those already mentioned, the same principle would still hold good. An infinite number of circles one for each of the possible planes in which the target could fly could therefore be constructed, all of them having "Y" as a centre and a radius of 2·24 inches.

14. Spherical Principle.

By taking a sufficient number of examples of target aeroplanes flying in the fashion described, a very large number of circles could be built up, all these circles 2·24 inches radius and all concentric. If this were carried on *ad infinitum*, the resulting circles would eventually produce a sphere.

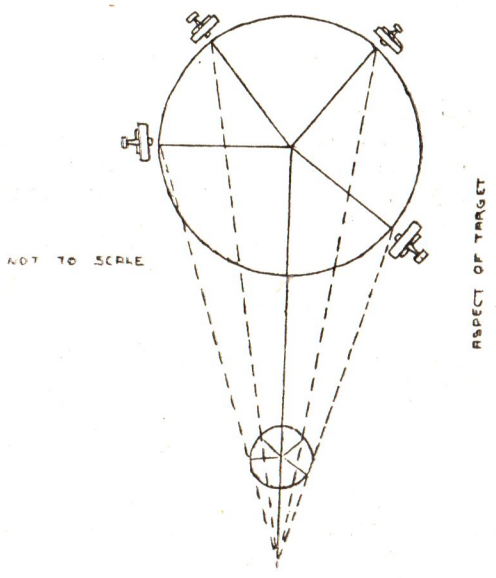


FIG. II.

Expressed in terms of sighting bars it can be said that if a sufficient number of examples of target aeroplanes flying from all directions across a gunner's front are taken, an infinite number of bars each 2·24 inches in length, and parallel to target aircrafts line of flight could be built up and these bars would eventually form a solid sphere of radius 2·24 inches.

From the above two conclusions can be arrived at:—

A. If a target aeroplane flies under the above assumed conditions, then at the correct moment of firing the target aircraft will always be 37·3 feet from the point where gunner's line of fire and the target's line of flight intersect. This point of aim can be in any one of an infinite

number of positions. The total of all these positions produces a sphere of radius 37·3 feet with points of intersection as its centre.

B. For sighting purposes this large sphere of 37·3 feet radius can be represented by a smaller one of 2.24 inches radius placed 36 inches from the gunner's eye.

The correct line of sight to the target aircraft would always touch the circumference of this sphere at the moment of firing.

15. The Ring Sight.

To use a sphere would not be practicable as it would have to be made of some transparent material. It would be fragile, therefore easily broken, and oil and dust would soon render it inoperative, so we replace the sphere by a single ring of 4·5 inches diameter (radius 2·25 inches). This device is then called a ring sight, and when of this size is placed 36 inches from the gunner's eye.

For target aircraft crossing at right angles to the line of flight of the gunner, no matter in what plane, the target will always be placed on the circumference of the ring at the moment of firing, provided the correct deflection is used.

For targets crossing at angles other than at right angles in any plane, the target will be inside the ring as seen by the gunner but flying towards the centre and can only be correctly positioned in the ring by continual practice.

It should be noted that the ring sight mentioned above is for certain assumed conditions. The fundamental principles, of course, always hold good, but distances, speeds and therefore the amount of deflection allowed will vary with conditions.

In sighting with the ring sight the gunner should imagine a crystal sphere around the ring sight, and place the target aircraft on the circumference of this imaginary sphere.

16. Range.

200 yards have been taken as the range when firing ·303 ammunition, but it also provides a useful guide for ranges above or below 200 yards. If the range is more than 200 yards the target is placed outside the

ring, and if below 200 yards a proportionate distance inside the ring. Through practice and experience alone can skill be acquired in judging such variation in ranges quickly and accurately.

17. Variation of Target's Speed.

We assumed 100 m.p.h. is a possible speed in air fighting. Gunners should know the type and ability of the opposing aircraft and will then have to make the necessary allowances for their variations in speed. Speeds of aircraft to-day frequently go up to 250 m.p.h. and for this it may be necessary to introduce an additional outside reference ring.

18. Variation of Sight Base.

36 inches has been taken as a standard length of the sight base. It may be shorter or longer, but the ring sight will then vary in direct proportion, i.e. ring sight will be smaller for a lesser length and larger for a greater length. The underlying principle remains unaltered.

19. Alignment of Sight.

The bead sight is used with the inner ring of the ring sight. This bead is used for *alignment* only and not for deflection.

The position of the bead can be any distance from the gunner's eye, and in practice it is usually same distance from the ring sight as the ring sight is from the eye.

20. Cone of Fire.

Up to the present the effect of jump of a gun has not been mentioned. Practice shows that with present mountings at 200 yards range all the bullets strike in an area enclosed by a circle of about 12 feet in diameter. This area is called the cone of fire. At this short range elevation corrections are so small that the trajectory is regarded as flat.

It is found that the best results are obtained if sights are so adjusted that the centre of the cone of fire coincides with the sight line.

LECTURE No. 3.

METHOD I.

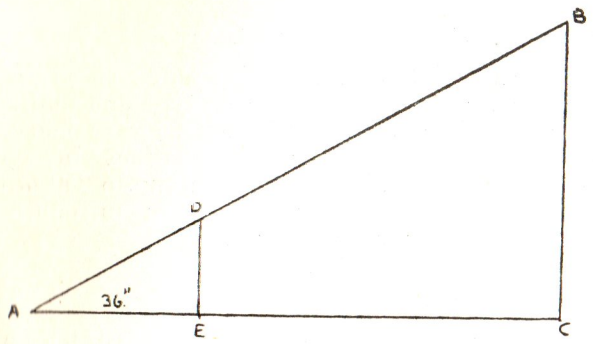


FIG. III.

21. Numerical Examples.

CALCULATING RADIUS OF RING SIGHT.

Given that:—

(i) Gunner's Speed = 120 m.p.h.
(ii) Target's Speed = 100 m.p.h.
(iii) Distance of the Ringe from the Eye (length of sight cone)— = 36 inches.
(iv) Fighting Range = 200 yards.
(v) Angle of Attack—At right angles to the flight path of the gunner.
(vi) Average Velocity of Bullet over Range = 2,186 feet per second (fired from rest).

Where AE represents sight base 36 inches.
AC represents range 200 yards or 600 feet.
BC represents deflection.
DE represents radius of ring sight.

Average velocity of bullet.. = 2,186 feet/sec. plus speed of gunner's Aircraft,

but speed of gunner's aircraft

$$= 120 \times \frac{22}{15} = 176 \text{ feet per second.}$$

Total velocity of bullet..... = (2,186 + 176) feet/sec.
= 2,362 feet/sec.

Time of Flight of bullet..... $= \dfrac{\text{Range in feet}}{\text{Average velocity of bullet over range in ft./sec.}}$

$$= \frac{600}{2{,}362} \text{ seconds.}$$

$$= 0{\cdot}254 \text{ seconds.}$$

Speed of target aircraft .... = 100 m.p.h.

$$= (100 \times \frac{22}{15} \text{ feet per second}$$

= 147 ft./sec.

During 0·254 seconds the target aircraft moves a distance of
$147 \times 0{\cdot}254 = 37{\cdot}3$ ft.
= BC in Fig. III.

△s ABC and ADE are similar.

$$\therefore \frac{AE}{AC} = \frac{DE}{BC}$$

$DE = \frac{36}{12} \times \frac{37{\cdot}3}{600} \times \frac{12}{1}$

Substituting values:—

$$DE = \frac{36}{12} \times \frac{37{\cdot}3}{600} \times \frac{12}{1}.$$

$$= 2{\cdot}24 \text{ Inches.}$$

Radius of Ring = 2.24 inches

METHOD II.

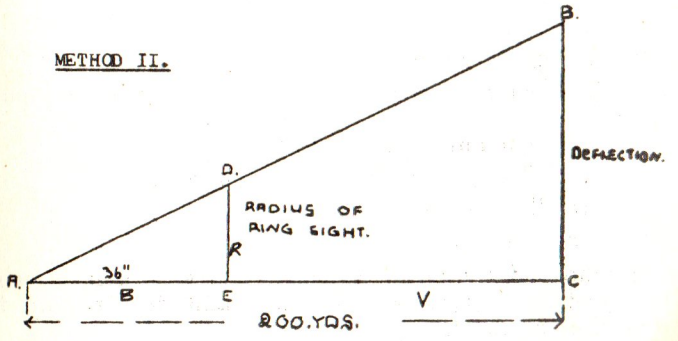


Fig. IV.

Using the formula $\frac{v}{V} = \frac{R}{B}$

Where v = velocity of target in ft./sec.
V = Average velocity of bullet in ft./sec.
R = Radius of ring sight in inches.
B = Length of sight base in inches.

Velocity of target..... = 100 m.p.h. = 147 ft./sec. (i)

Total velocity of bullet. = Average Vel. + Gunner's Vel.
= (2,186 + 176) ft./sec.
= 2,362 ft./sec. (ii)

Length of sight base.... = 36 inches. (iii)

Substituting (i), (ii) and (iii) in formula—

Then $\frac{147}{2362} = \frac{R}{36}$.

$R = \frac{(36 \times 147)}{(2362)}$ Compare with Method I.

Radius of Ring Sight = 2·24 inches.

These examples show that given any three conditions, the fourth, to suit the problem, can easily be calculated.

[NOTE.—The following is always necessary:—

A. Firer's eye, bead and centre of the ring must be in the same straight line.

B. Firer's eye must be a definite known distance from the ring sight.

C. Target must fly towards centre of the ring.]

LECTURE No. 4.

---

22. Description of Ring and Bead Sights.

(i) The Ring Sights—consists of the following main parts:—

(*a*) The outer ring.

(*b*) The four radial supporting wires.

(*c*) The inner ring.

(*d*) The stem.

The whole of the sight is made of steel and is browned for protection against corrosion and to prevent the reflection of light.

The inner ring is $^{15}/_{16}$ inch in diameter.

The stem is approximately 3 inches in length, of $\frac{3}{8}$ inch in diameter and is threaded for all but $\frac{1}{4}$ inch of its length.

Two hexagonal nuts and two circular washers fit on to the threaded stem, to provide a means of fixing the stem to a suitable part of the aircraft and to allow for adjustment of the sight during harmonization.

The Bead:

This is a steel rod 6 inches in length. The lower end or stem is threaded for 3 inches and is in other respects similar to the stem of the ring sight. The bead is made integral with the stem, is about $\frac{3}{8}$ inch in diameter and is coloured a bright red.

23. Aldis Tube Sight.

Description:—

(i) The Aldis sight, is an optical arrangement, to outward appearances a telescope, which does not magnify or diminish. The arrangement of the four lenses inside of it is such that it may be used with both eyes open, one eye looking through and one eye outside it. When objects are looked at through the tube, they appear exactly as if the tube were not there.

(ii) The sight is accurate within considerable limits of the position of the eye, the best effect being obtained however, when the eye is about 5 inches from the rear lenses. The total field of view in this position is about 15°.

(iii) Within the tube, is a plain glass graticule screen on which there are engraved two concentric circles, the image of which is seen in the field of view when looking through the tube. The inner circle is small and serves to define the optical axis of the tube.

(iv) The outer circle or sighting ring corresponds to a target speed of 100 m.p.h. and is used like the ring sight for obtaining the necessary deflection allowance.

(v) The optical arrangement of the sight is such that when a target is visible through it appearing "positioned" on the graticule ring, a small movement of the gunner's eye does not alter the relative position of the target on the graticule.

(vi) The gunner is saved the necessity of positioning his eye accurately by using a bead. He thus has two objects only, target and graticule, to consider, instead of three.

(vii) The front or object end of the sight is provided with a " Hinged Flap " to protect the lenses from oil, etc. This is operated by a light cable and is opened by pulling it back before use.

(viii) The sight is attached to the aircraft by two clips.

24. Common Errors.

Many pilots are of the opinion that the deflection allowed varies in direct proportion with the angle of attack and therefore they allow full deflection for a 90° angle of attack and exactly half of that deflection for an attack at 45°.

THIS IS INCORRECT.

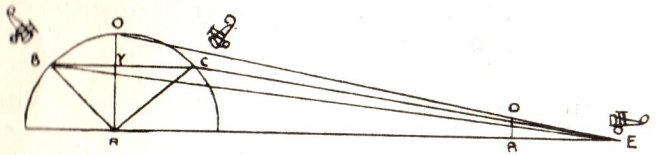


FIG. V (not to scale).

Target approaching at 45° on same plane as the gunner:—

RD = Radius of ring sight.
EA = Gunner's line of flight.
BA & CA = Target's line of flight.

Sighting from E the target is placed on the circumference of an imaginary sphere BOC. B and C represent points on the circumference and AB and AC is therefore the correct deffection.

The ring sight DR is placed at right agles to the gunner's eye and when drawn to scale the lines of sight to B and C coincide for all practical purposes at a point X on the ring sight as shown in figure VI.

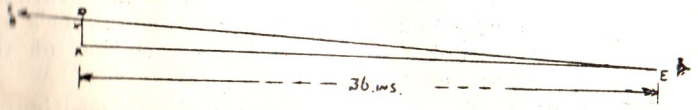


FIG. VI (to scale).

(FIG. VI.) $\frac{RX}{RD} = \frac{AY}{AO}$ (FIG. V.) = 7/10

Therefore for a target approaching at 45° on the same plane as the gunner, $^{7}/_{10}$th deflection should be allowed and not a half. Similarly it can be shown for an attack at 30° a half deflection should be allowed, and not a third.

LECTURE No. 5.

FREE GUN SIGHTS.

25. General Principles.

(i) Free Guns are those which are so mounted on an aircraft that the line of fire relative to the aircraft may be varied at will. This gun is mounted in such a manner that it may be traversed over as large an area as may be practicable with the type of aircraft carrying it. This area is known as the " field of fire ".

(ii) Guns fitted in this manner are generally operated by an observer or aerial gunner.

(iii) Mounting aerial guns as free guns introduces a new factor into the construction of aerial sights. With fixed guns the velocity of the bullet was added to that of the aircraft from which it was fired, since both the bullet and the aircraft travelled in the same direction. With the free gun, however, this condition is seldom if ever satisfied and it is therefore necessary to introduce some device which will allow for the gunner's " own speed " no matter in what direction he fires.

The fundamental problem of laying the gun so that the bullet and target arrive at the same point at the same moment, however, still remains the same.

26. Aspects of the Target.

(i) The target aircraft may present itself to the gunner in one of the following ways:—

(*a*) It may be flying directly towards or directly away from the gunner along the line of flight of his own aircraft.

(*b*) It may be moving along a line of flight that makes an angle with the gunner's aircraft, but in such a way that his gun may be pointed along his own line of flight.

(*c*) It may be moving along a line of flight parallel to that of the gunner's aircraft, either in the same direction or in the opposite one.

(*d*) It may be moving along a line of flight which makes an angle with that of his own aircraft, but in such a manner that his gun cannot be pointed along his own line of flight.

(ii) In (i) (*a*) above the sighting principles are exactly the same as would be used for a fixed gun. The gun is pointed along the gunner's line of flight, and the target is always on that line.

(iii) When the conditions are as outlined in (i) (*b*) the gunner would follow exactly the same principles as if he were firing a fixed gun at a target which required a deflection shot. An ordinary ring sight as part of the sighting arrangements would satisfy (i) (*a*) and (*b*).

27. Allowance for Gunner's "own speed".

(i) In sub-paragraphs (i) (*c*) and (*d*) above the gunner is not firing along his own line of flight, but at an angle to it. This cannot be allowed for by using a ring sight only. It is therefore necessary to appreciate the nature of the motion of the bullet, after it has been fired. The bullet is subject to two velocities neglecting that due to gravity:—

(*a*) The velocity produced by the charge.

(*b*) The velocity given to it by the aircraft.

The effect of combining these two velocities is as follows:—

(*a*) The velocity given it by the charge causes the bullet to travel in a direction parallel to the line of the barrel.

(*b*) The velocity given it by the aircraft causes the bullet to travel in a direction parallel to the line of flight.

(iii) If these two velocities can be taken as the two sides of a velocity triangle the closing side of the triangle will represent the resultant velocity of the bullet. This applies to whatever angle the gun makes with the line of flight of the gunner's aircraft, but the drift angle "A" is a maximum when the angle between the axis of the barrel and the line of flight of the aircraft is a right angle.

28. Sights compensating for Gunner's Own Speed.

(i) The problem of finding the necessary deflection to be allowed to compensate for the speed of the gunner's own aircraft is solved by the use of a sight, which

automatically places the barrel of the gun at such an angle of deflection that the required line of fire can be established no matter in what direction the gun is pointed in relation to the gunner's aircraft. The gunner is therefore relieved of all responsibility in making the deflection allowance for his own speed.

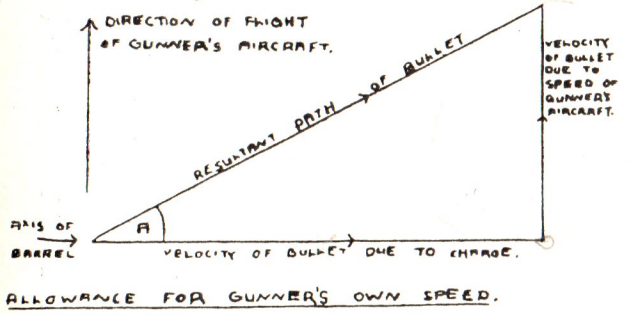


FIG. VII.

(ii) The two velocities of the bullet as it leaves the gun are reproduced on a small scale (both in magnitude and direction) in the arrangement of the sight. The velocity produced by the propellant is represented by a sight base which is always parallel to the axis of the bore of the gun, wherever it may be pointed. The velocity given to the bullet by the aircraft is represented by a small movable arm attached to the outer end of the sight base, and which is always maintained parallel to the line of flight of the aircraft by means of small vanes which are acted on by the slip stream.

(iii) A line taken from the inner end of the base, through the outer end of the arm therefore gives the required line of departure of the bullet.

(iv) This applies even if the gun is elevated, or depressed, and, provided the sight is mechanically perfect and maintains the arm parallel to the line of flight under all conditions, the correct deflection to allow for "own speed" will be automatically given.

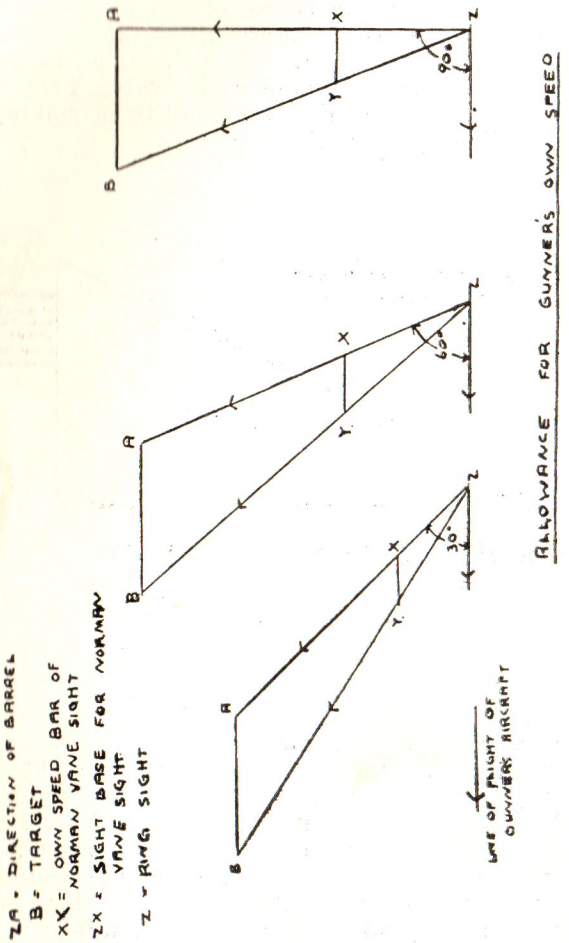


Fig VIII.

LECTURE No. 6.

29. Data required for the construction of "Own Speed Sight".

The following information will be required in order to devise a suitable sight:—

(i) The length of the sight base.

(ii) The muzzle velocity of the bullet.

(iii) The velocity of the aircraft at the moment of departure of the bullet.

30. Data given (Standard).

Assume the following conditions for the sight under consideration:—

Velocity of the gun platform = 100 m.p.h = 147 feet per sec.

Muzzle velocity of the bullet = 2,440 feet per sec.

Length of sight base = 17·92 inches.

31. Angle of Deflection for "Own Speed" in Right Angled Attack.

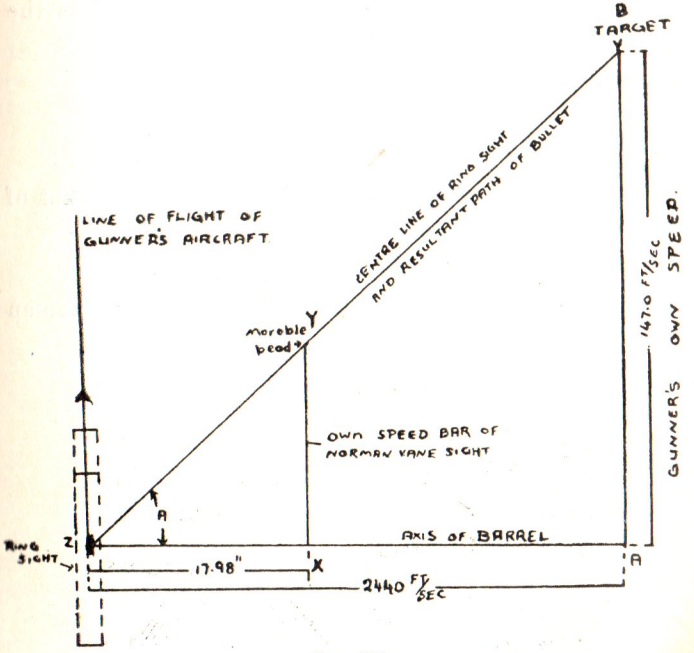


Fig. IX.

If it is required to know what angle the bullet would make with the axis of the barrel if the gunner is to project the bullet at right angles to his line of flight [angle "A" in (Fig. IX)], this can be obtained from

$$\text{Tangent "A"} = \frac{\text{Velocity of Aircraft.}}{\text{Velocity of Bullet.}}$$

$$= \frac{147}{2440}$$

Given the above data, however, it is not necessary to calculate this angle to construct the Norman Vane Sight:

This can be done as follows:—

32. Numerical Example for the construction of a Norman Vane Sight.

Assume a stationary target being fired at from an aircraft moving 100 m.p.h. (Ring sights are also fitted to free guns to allow for "enemy speed" similar to those rings fitted to fixed guns, but when firing at stationary targets the centre of the ring is used as the back sight.)

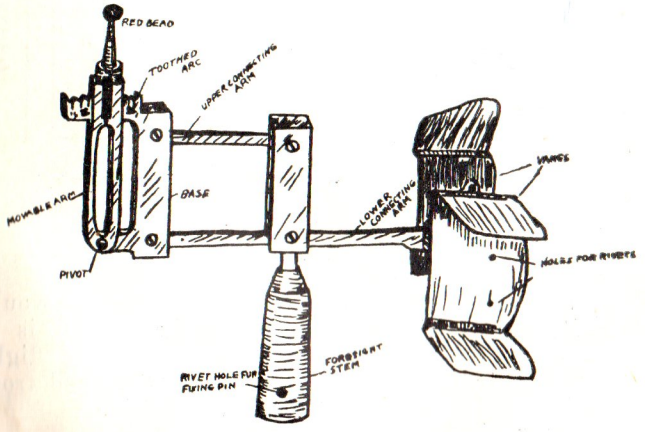
Given:—

Speed of gunner's aircraft = 100 m.p.h.
= 147 ft./sec.

Distance between socket of ring sight and socket of wind vane sight = 17·92 inches.

Muzzle velocity of Lewis' gun = 2,440 ft./sec.

To find the length of "own speed" bar for Norman Vane Sight—



NORMAN VANE SIGHT.

FIG. X.

The triangles ABZ and XYZ are similar for all angles of fire (Fig. IX).

$$\therefore \frac{XX}{XZ} = \frac{BA}{AZ} = \frac{147}{2440}.$$

$$XY = \frac{147 \times 17{\cdot}92}{2440} = 1{\cdot}08 \text{ inches.}$$

= Length of "own speed" bar.

NOTE.—When this sight is used the gunner must ensure that his eye, the bead and the centre of the ring are in the same straight line.

Further when the ring sight is being used together with the "own speed sight bar", to allow for "enemy speed," when firing at a moving target, the following conditions also apply:—

(i) The gunner's eye must be a definite distance from the ring sight.

(ii) The target aircraft must be placed so as to be flying towards the centre of the ring.

33. Procedure when using the Norman Vane Sight.

(i) The procedure when using the ring sight has been set out in paragraph 15 and is also applicable when used in conjunction with this sight.

(ii) When using the two sights together the gunner must keep the bead of the foresight in the centre of the ring sight and then allow on the ring sight for "enemy speed" as in paragraph 15. This will involve small movements of the head as the gun is moved, because the position of the foresight bead in relation to the barrel is variable depending on the relative positions of the gun centre line and the light of flight of the aircraft.

34. Description of the Norman Vane Sight.

(i) Foresight consists of the following main parts:—

(*a*) *The Bead Unit* consists of a movable arm and a squared base in all about 3 inches in length. The square portion of the base is slotted, drilled and threaded to take the top and

bottom connecting arm axis screws. The movable arm is pivoted at the lower end of the squared base and moves over a toothed arc at its upper end. The arc is numbered 2, 4, 6, 8, which indicates the position of the ratchet when own speeds of 120, 140, etc. m.p.h. are being allowed for. The upper end of the arm terminates in a red bead.

(*b*) *The Fore-sight Stem.*—The fore-sight stem is about 2½ inches long, the lower portion is cylindrical and fits into the base, being retained in position by a fixing pin riveted over. The upper portion of the stem is square and slotted. The connecting arms pass through the slot and are pivoted in position by two screws which pass through the squared portion. The base has a conical top and is drilled longitudinally for a short distance to receive the foresight stem. A hole is drilled transversely in the base to take a split pin that retains the base in position on the foresight bracket.

(*c*) *The Wind Vanes.*—Two wind vanes are made of sheet duralumin with ends turned up at right angles. Two holes are drilled in each vane to take the rivets that attach the vane to the lower connecting arm.

(*d*) *The Connecting Arms.*—The connecting arms are two in number, the upper arm and the lower arm. The upper arm has at either end two axis pivots. The lower arm is longer than the upper arm. At one end of the lower arm is one axis pivot and about two-thirds along the arm another pivot. The other end of the arm is splayed out into two parts, the ends of which are enlarged to receive the two rivets that attach the vanes to this connecting arm. The distance between pivot centres on both arms is the same, by this means a parallel action is obtained between the bead base and the sight stem.

(ii) The Ring Sight:

(*a*) *The Outer Ring.*—Duralumin 2½ inches in internal diameter and having a depth of ⅜ inch.

Three holes are drilled in the periphery, through the centre one of which passes the stem supporting the inner ring; the two outer holes are utilised for rivets which secure the outer ring to the sight stem.

(*b*) *The Sight Stem* has an overall length of 4 inches and is ⅜ inch in diameter; an ⅛ inch hole is drilled transversely to take the retaining split pin; the upper end is flanged to provide an attachment for the outer ring. The sight stem then tapers to $^{1}/_{16}$ inch diameter and has attached to it the inner ring.

(*c*) *The Inner Ring* is concentric with the outer, has an external diameter of ⅜ inch and is $^{3}/_{16}$ inch depth.

(iii) Marks on the Sight:—

(*a*) *The Fore-sight* has stamped letters and figures on the upper surface of one of the wind vanes indicating the speed in m.p.h. for which it is designed to compensate.

(*b*) *The Ring Sight* has stamped letters and figures which indicate the speed of the target aircraft for which allowance is made.

LECTURE No. 7.

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35. Numerical Examples.

Two A/C are flying at the same height at a distance of 200 yards apart on parallel courses.

Own Speed	230 m.p.h.
Own Speed Sight (Norman Vane) ...	200 m.p.h.
Enemy Speed	260 m.p.h.
Enemy Speed Sight (Ring)	210 m.p.h.

Time of flight of bullet over range is ·2 seconds.

If you take a normal aim under the above conditions what would be the approximate position of the bullet relative to the enemy aircraft (*a*) when flying on reciprocal courses (*b*) when flying on parallel courses?

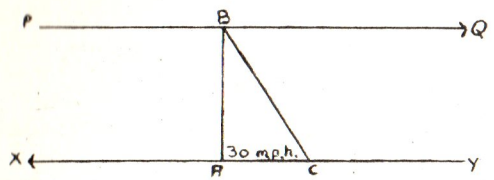


FIG. XI.

If gunner and target were flying at speeds which corresponded to the speeds for which the sights were constructed, the bullet and the target would meet at a point known as the point of intersection.

PQ. represents path of Gunner's A/C.
XY represents path of Target A/C.
AB, range of 200 yards.
Pt. A, point of intersection.

(*a*) Flying on reciprocal courses:—

CASE No. 1.

To calculate position of the bullet relative to pt. A. when flying at 230 m.p.h.:—

If the gunner had been flying at 200 m.p.h. (own speed sight speed) bullet would intersect XY at A, but he is travelling at 230 m.p.h. Therefore bullet will be carried past A by a time distance of (230-200) m.p.h. i.e., 30 m.p.h. and arriving at pt. C.

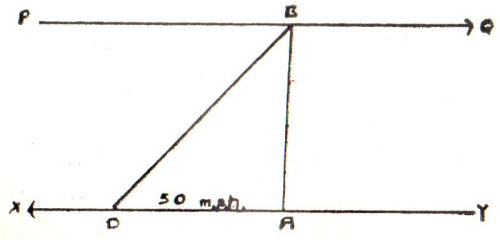


FIG. XII.

CASE No. 2.

To calculate position of target relative to pt. A. when target is flying at 260 m.p.h.:—

If target were flying at 210 m.p.h. (Enemy speed sight) it would meet the bullet at pt. A. but it is flying at 260 m.p.h. Therefore target will pass pt. A. by a time distance of (260-210) m.p.h., i.e., 50 m.p.h. and arrive at pt. D.

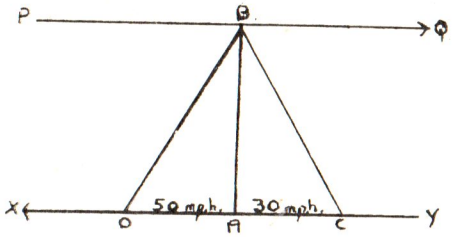


FIG. XIII.

Now combine Cases Nos. 1 and 2.

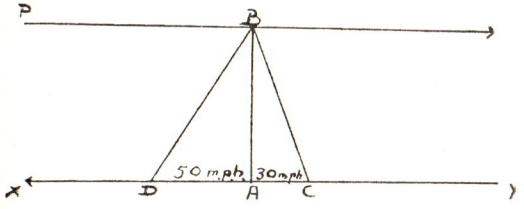


FIG. XIV.

CASES Nos. 1 AND 2 COMBINED.

The sum of the time distances between bullet and target is therefore (30 + 50) m.p.h., i.e., 80 m.p.h.

$$80 \text{ m.p.h.} = (80 \times \frac{22}{15}) \text{ feet/sec.}$$

$$= 117\tfrac{1}{3} \text{ feet/sec.}$$

The distance which the bullet will pass behind the target aircraft = Time distance × Time of flight.

$$= 117 \cdot 3 \times \cdot 2$$

$$= 23 \cdot 46 \text{ ft.}$$

(b) Aircraft flying on same Courses :—

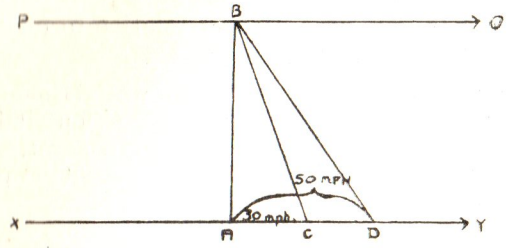


FIG. XV.

Cases 1 and 2 combined now appear as shown above where :—

Pt. C. represents position of the bullet, a time distance of 30 m.p.h. to the right of pt. A., and

Pt. D. represents position of the target, a time distance of 50 m.p.h. to the right of pt. A.

Therefore, the time distance between points C and D, i.e., between bullet and target, is :—

$$(50-30) \text{ m.p.h.}$$

$$= 20 \text{ m.p.h.}$$

$$20 \text{ m.p.h.} = (20 \times \frac{22}{15}) \text{ feet/sec.}$$

$$= \frac{440}{15} = 29\tfrac{1}{3} \text{ feet/sec.}$$

The bullet is, therefore, in rear of the target a distance of $\cdot 2 \times 29 \cdot 3$ ft. $= 5 \cdot 86$ ft.

For numerical example for the construction of own Speed Sight see paragraph 32.

For numerical example for the construction of Enemy Speed Sight see paragraph 21.

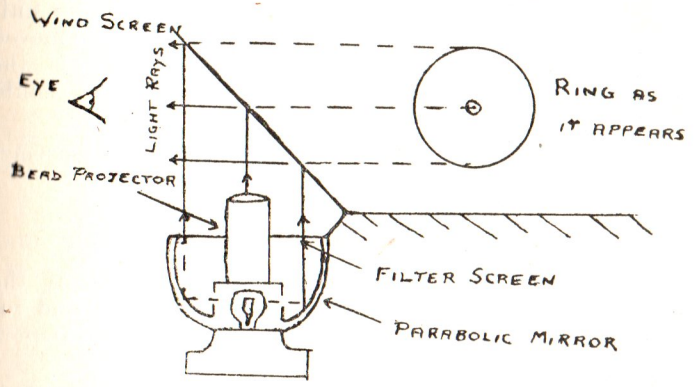
LECTURE No. 8.

MODERN SIGHTS.

36. Reflector Sights.

In modern high speed A/C such as the Hurricane Blenheim, etc., streamlining is an all important consideration and for this reason external protruding parts and fittings such as Ring Sights—Aldis Tube Sights, etc., have had to be discarded. To take their place the Reflector Sight has been designed which consists briefly of the following.

The reflection of a ring of correct dimensions is thrown on the Aircraft windscreen and is visible only when the eye is in the correct line of sight. All deflection for Enemy Speed is then allowed for on the ring.



37. General Principles.

There are two types of sight one for pilots use and one for observers use. They are identical in principle but details of construction are different.

A " ring and bead " graticule is illuminated by an electric lamp and projected by means of an optical system on to a reflector screen of special triplex glass which is interposed on the line of sight at 45° thereto.

The target is looked at directly through the reflector screen and the " ring and bead ", although seen by reflection, appears to be superimposed on the target and effectively at the same range as the target.

By this means the general view round the target is not obstructed in any way and there is no necessity to try to see clearly and at the same time near objects such as the backsight and foresight and distant objects such as the target.

In addition the system of projection is such that the eye has considerable freedom both fore and aft and laterally without introducing a sighting error of any appreciable magnitude.

38. Constructional Details Common to Both Types of Sight.

The graticule is illuminated by a twin filament lamp. A high Candle filament is used for day work and a low candle power filament, which can be dimmed by means of a rheostat, is used for night work.

The low candle power filament is positioned centrally in the bulb and the high candle power filament is offset. It is of importance to have the lamp the correct way round in the lamp holder. To test this the lamp unit is removed from the sight and the control switch moved to H.C.P. The offset filament should light. If the switch is moved to " L.C.P." the central filament should light and be controlled by the rehostat.

Lamps should be replaced when the bulb becomes blackened unduly by use.

39. The Pilots Sight.

(*a*) *The Reflector Panel.*—The centre panel of the pilot's windscreen is used as the reflector panel and for this purpose it has to be made of optically flat triplex glass.

The framing for this reflector panel carries the ball seating for the optical unit.

The framing also carries a sun screen of smoked triplex glass which can be interposed between the reflector panel and the target when the target is against a very bright background or near the sun.

(*b*) *The Optical Unit.*—The graticule, which provides the ring and bead, is in two parts. The bead is provided by a small hole in a plate and by means of a lens system the light from the hole is focussed at the pilot's eye after reflection from the reflector panel.

The lens holder is expanded in its lower half and the skirt is provided with a narrow circumferential slit which provides the " ring " of the " ring and bead ".

Light from the slit falls on to a stainless steel parabolic mirror and is then focussed at the pilot's eye after reflection from the reflector panel. A light filter is interposed between the mirror and the reflector panel.

The sight is harmonised by adjusting the optical unit on its ball seating after the two securing nuts have been eased off.

40. The Observers Sight.

(*a*) *The Reflector Panel.*—This is of small size and carried on the lens holder. The same frame carries the sun screen which is stowed vertically downwards and held vertically upwards when in use.

The sight is harmonised laterally by adjusting the reflector panel frame on the lens holder after easing the clamping screw.

Vertical harmonisation is carried out by adjusting the small vice screws which rock the reflector panels.

(*b*) *The Optical Unit.*—The graticule, ring as well as bead, is formed in a metal plate and the light from it is reflected vertically by means of a prism and then focussed at the gunner's eye, after reflection at the reflector panel, by means of a lens system.

(*c*) *The Lamp Unit.*—This unit contains the rheostat and is detachable from the body of the optical unit for inspection or replacement of the lamp.

The observer's sight is generally mounted on a bar which is arranged to correct for " own speed " by special gearing which controls one end of the bar. The " ring and bead " is therefore used in a manner precisely similar to that of the pilot's sight to obtain corrections for enemy speed only.

General Precautions :—

(*a*) See that the double filament lamp is correctly positioned in its holder.

(*b*) Put the tumbler switch in the lamp circuit to " off " except during the period when the sight is in use. This will ensure that the filament is not alight for long periods unintentionally. The lamp will not then blow when it is actually required for use.

41. Relative Speed Sight.

In 1939 the R.A.F. decided to adopt the Relative Speed Sighting Principle in place of the principle embodied in existing gun sights.

Before this decision was reached trials lasting two years had been carried out to obtain data on the possibility of attack by manoeuvre with modern aircraft.

Since the Relative Speed Sight breaks down under conditions of attack by manoeuvre, it was important to assess the probability of such attack first of all before examining the possible advantages of the Relative Speed Sight.

Attack by Manoeuvre.—In the trials a "Spitfire" was used as an attacking aircraft and a Fairey Battle (190 m.p.h.) as a bomber to determine the limiting manoeuvre for a single-seater attack.

These trials showed that with modern high speed aircraft the quarter attack was only just possible and even in this instance the fighter could not bring accurate fire to bear until the relative inclinations were about 30°. From this point the attack rapidly developed into a stern chase.

It was also found in these attacks that the closest range from which the fighter could hope to attack, if he was to get his target satisfactorily in his sight ring and keep him there, was 1,000 yards. The time from the commencement of the attack to the time when the fight developed into a stern chase was approximately 12 seconds. Of this period of time it was estimated that only $1\frac{1}{2}$ seconds were available for actual firing when the conditions for range and correct deflection were satisfied. In addition to these difficulties, pilots reported that great difficulty was encountered in positioning the bomber in the sight during the $1\frac{1}{2}$ seconds owing to the rapid change of inclination.

In practice they found that the best method of attack was to deploy into a position for a stern chase well out of range and to close as rapidly as possible. Thus the attack really becomes a matter of parallel courses.

Pilots also found that the effect of centrifugal force (G) during the curve of pursuit was most pronounced and interfered with the accuracy of aim. Blacking out being quite common.

Very few of the old orthodox attacks as taught at the moment could be used.

All attacks from further ahead than the beam attack was found to be impossible.

It has therefore been decided that the "dog-fight" as known during the last war will disappear, and that the greater part of fighting will develop into a running fight on large enemy formations near their objectives in an attempt to break them up.

It seems very unlikely that individual aircraft will stay to fight but will make use of their speed and remaining endurance in an attempt to get back, in which case conditions of the stern chase will again set in.

Since the success of the sight depends entirely on the maintaining of parallel courses it has been fully realised that in adopting the Relative Speed Sight the whole principle would be violated if attack from an angle, i.e. by manoeuvre, were still possible. In practice, however, it was found that for inclinations up to about 20° the sight could be satisfactorily used and that the errors would still be less than those incurred when using the Standard Sight.

42. Instructions for Use.

Introduction.—When firing a free gun from an aeroplane at another aeroplane there are two main factors which influence the point of aim:—

(i) The velocity imparted to the bullet by the movement of the air gunner's aeroplane.

(ii) The velocity of the target.

These two factors may be treated separately when designing gunsights, or they may be combined and only the resultant velocity considered. The relative speed sight is designed in accordance with the latter principle. Each type of sight has certain operational or mechanical disadvantages, but as the high speed of modern aeroplanes reduces the likelihood of combat by violent manoeuvre and tends to enforce engagement on parallel courses, the main advantage lies with the relative speed sight, which is simple, both in construction and in use for this type of engagement.

43. Description of Sight.

1. In principle the sight consists of a fixed bead fore-sight and a ring back-sight. The radius of the ring represents the correct deflection to be made for a relative speed sight of 50 m.p.h. at right angles to the line of fire. In calculating the size of this ring an average bullet velocity up to 300 yards range has been taken.

2. In the preceding paragraph mention has been made of a fore-sight, but in optical sights such as the reflector type the air gunner's eye is correctly positioned

by the optical system and a fore-sight is therefore unnecessary, the air gunner only seeing a luminous ring representing the 50 m.p.h. deflection circle and a small central dot representing the bead.

3. *Principles of relative speed sighting.*—When using the relative speed sight, the air gunner is concerned with the *apparent movement of the enemy relative to his own aeroplane.* He considers only the resolved component of the relative velocity in a plane perpendicular to his line of fire, i.e. in the plane of the ring. In short, he allows for what he sees.

4. The direction of the apparent motion of the enemy must always be made *to pass through the centre of the ring* while the amount of deflection to be allowed is determined by the *apparent speed of the target across the line of sight.*

44. Method of Use.

(*a*) (i) Having located the enemy, the gunner places him in the centre of the ring, and, without moving the sight, observes momentarily the apparent motion of the target relative thereto. [See Fig. 1 (*a*).]

(ii) The direction of this motion being decided, the air gunner then moves his sight along it, following and overtaking the target, so that the apparent motion of the enemy is now directed towards the centre of the ring. [See Fig. 1 (*b*).]

(iii) The air gunner then estimates the apparent speed across his line of sight and, using the 50 m.p.h. circle as a scale, makes the appropriate radial allowance, i.e. deflection [see Fig. 1 (*c*).]

(iv) Having fired a burst, the air gunner repeats this procedure.

(*b*) It is emphasised that there are three distinct types of attack:—

(i) Where the enemy is flying directly towards the air gunner, i.e. as in a single seater attack.

(ii) Where the enemy is following a more or less parallel course, i.e. as in a two-seater fighter attack.

(iii) A crossing-shot, as when manoeuvring for position or when firing at an aeroplane which is attacking another aeroplane of the formation.

Of these three types, the first two are the more probable and present little difficulty in relative speed sighting. The crossing-shot, however, is more difficult and requires a high degree of of judgment, but it should be borne in mind that the general tendency is for a crossing-shot to develop into an action on parallel courses should the engagement be maintained. Furthermore, the high relative velocities incurred by such a shot preclude accurate shooting and fire should be withheld until conditions have become more stable and therefore more favourable.

45. Effect of Air Resistance on Trajectory of Bullet.

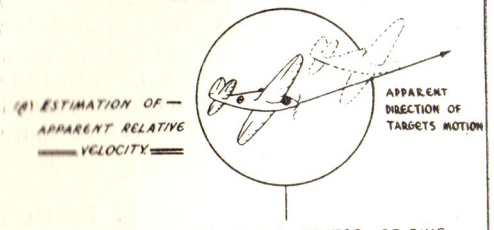
1. When the bullet leaves the muzzle, it assumes a trajectory which, gravitation ignored, is the resultant of the muzzle velocity, and the aeroplane velocity, but the effect of air resistance retards the bullet throughout its flight. The lateral component of this resistance arising from the translational velocity of the air gunner's aeroplane, gives rise to bullet trail. The apparent path of a bullet fired on the beam, if it could be observed by the air gunner, would appear to lag behind the line of departure as shown in Fig. 2.

2. Air gunners should be trained to make the necessary allowance for this effect, which, at ranges, heights and speeds envisaged for air action, varies from about 12 feet for fire on the beam to zero for fire ahead or astern. In general, the gun should be laid off an appropriate amount towards the nose of the air gunner's aeroplane. In the particular case of parallel course actions the same effect can be achieved by taking the nose of the enemy aeroplane as the laying-point.

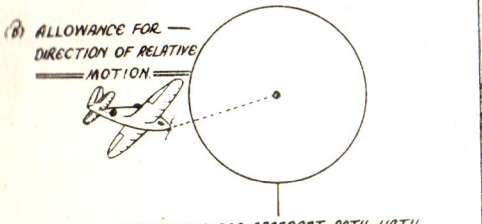
46. Illustrations to Amplify the Text.

The attached diagrams, which are self-explanatory, illustrate typical shots, and training should be directed towards the rapid assessment of the necessary sighting allowances to be made when using the relative speed principle.

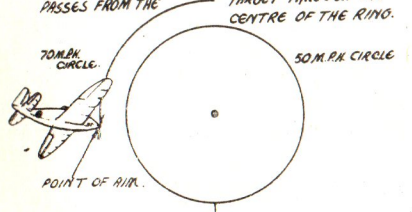
(Method of use Fig 1.



1. Place target in centre of ring
2. Keeping sight stationary, observe direction and speed of apparent motion of target across the ring.

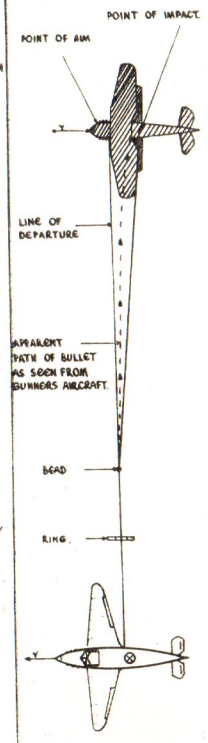


1. Move sight along apparent path until target is overtaken and passed.
2. Maintain position of target relative to ring so that the direction of the observed motion passes from the target through the centre of the ring.



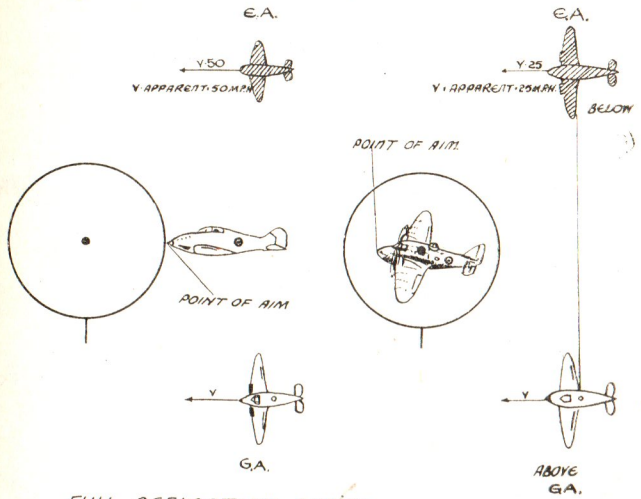
(c) Allowance for speed of relative motion.

1. Keep the path of apparent motion directed towards the centre of the ring, as in (b)(2).
2. Place the nose of the enemy aircraft at a radius corresponding to the estimated speed of the target across the ring. (Correct deflection for 70 M.P.H. is illustrated)



Beam fire on parallel courses. Relative Speed Nil.

Bullet Trail Fig 2.



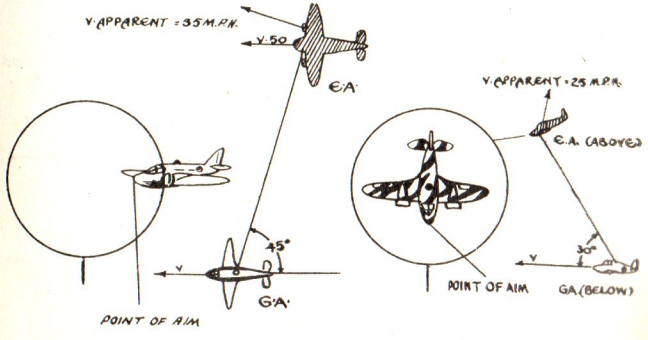
Full deflection shots

(Beam fire on parallel courses.)

Enemy aircraft overtaking gunner's aircraft at 50 M.P.H. Rel. speed on same level.

Gunner's aircraft overtaking enemy aircraft at 25 M.P.H. Rel. speed on different level.

Fig. 3A.

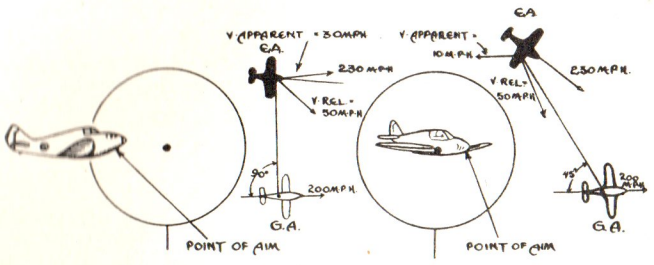


Partial deflection shots

Quarter fire on parallel courses. Enemy aircraft overtaking gunner's aircraft at 50 M.P.H. Rel. speed on same level.

Upward fire on parallel courses. Gunner's aircraft overtaking enemy aircraft at 50 M.P.H. Rel. speed on different level.

Fig. 3B. Relative speed sights, typical examples.

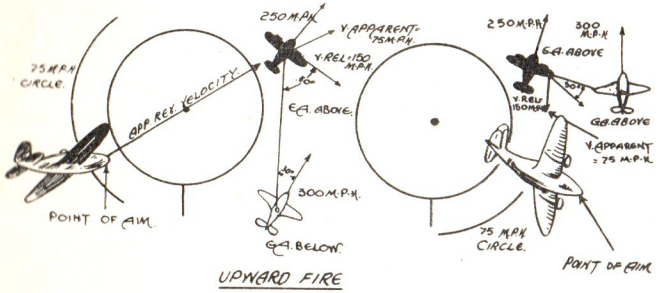


CROSSING SHOTS.

BEAM FIRE — QUARTER FIRE

ENEMY AIRCRAFT OVERTAKING GUNNER'S AIRCRAFT ON CONVERGING COURSE AT 50 M.P.H. RELATIVE SPEED ON SAME LEVEL. 7½ 3C

FIG. 3C.



UPWARD FIRE

QUARTER FIRE — BEAM FIRE.

GUNNER'S AIRCRAFT OVERTAKING ENEMY AIRCRAFT ON CONVERGING COURSE AT 150 M.P.H. RELATIVE SPEED ON DIFFERENT LEVEL.

FIG. 3D. RELATIVE SPEED SIGHTS. TYPICAL EXAMPLES.

FIG. 3D.

LECTURE No. 9.

HARMONIZATION.

HARMONIZATION OF AIRCRAFT SIGHTS.

46. Definition.

A sight is said to be harmonized with its gun when the point of impact of the bullet at some given range is

positioned on the line of sight at that range. The point of harmonization therefore is that point at which the line of sight and the trajectory intersect.

47. General Remarks.

As no gunner can hope to hit a target unless his gun sights are correctly harmonized, it is of vital importance that this operation be carried out with great care. As most sights are of a relatively delicate nature and the slightest damage will upset the harmonization, it is necessary to check the harmonization as often as is possible.

48. Fighting Range.

It is undesirable to lay down that the point of harmonizations should be at any definite distance from the gun, as tactical considerations and the preference of each individual pilot would be affected. As a general rule, however, sights should not be harmonized on a point more than 200 yards distant, and as the trajectory of the bullet is virtually flat (i.e. gravity fall is only 14·4 inches at 200) up to this range, it is usually adopted. Sights that are harmonized for 200 yards are effective at all ranges below this distance and no benefit is gained by harmonizing to a longer range under the existing conditions of warfare in the air.

49. Methods of Harmonization.

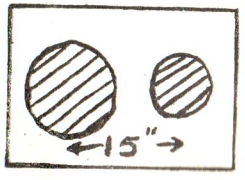
Two methods are available for harmonizing sights:—

(1) By sighting through the barrel.

(2) By firing the gun and aligning the sight on the centre of impact of the bullets.

The first method lends itself to free guns and the second to fixed guns but either may be used indiscriminately as may be desired and as local facilities permit.

For visual harmonization a board is used marked as shown.



The lower mark is used for guns and sights for ranges up to 100 yards, whereas for ranges from 100 to 200 yards the upper mark is used for the sights and the lower for the guns.

50. Detail of Procedure for a Vickers Gun (Barrel Reflector Method).

(i) Place the aircraft in flying position.

(ii) Set up a conspicuous aiming mark at the required distance and in the flight path of the A/c.

(iii) Remove the lock from the gun of which the sight is to be harmonized and place the barrel reflector in the chamber, noting that:—

(*a*) It is pushed right home in the Chamber.

(*b*) That the bore is reflected vertically upwards.

(iv) Move the aircraft until the fore and aft line of the A/c, obtained from plumbobs hung from the propeller boss and tail, is in line with the aiming mark.

(v) By means of the adjustable brackets on the guns align them so that the top aiming mark appears to be concentric with, but inside, the circle formed by the muzzle.

(vi) Place the head in the correct position in relation to the ring and bead sight, and adjust them until they bear on the bottom aiming mark (NOTE: This must be done in full flying kit).

(vii) Check this position of the sights by disturbing the aim and repeating sub-paragraphs (i)-(vi).

51. Detail of Procedure for a Vickers Gun (Firing Method).

(i) Place the aircraft firmly fixed in the flying position at the required distance (say 100 yards) from a stop butt.

(ii) Set up a target at the butts as in paragraph 50 (ii).

(iii) Move the A/c as in paragraph 50 (iv).

(iv) Observing local range orders, fire a burst of about 10 rounds at the target.

(v) Mark the centre of the group on the target in a conspicuous manner.

(vi) Align the ring and bead sights on to the centre of the group, keeping the head in the correct position.

(vii) Check by using the alignment found, as a director on to a target, and firing a short burst to ascertain if the centre of the group is on the mark sighted at.

52. Detail of Procedure for a Lewis Gun Sighting through the Barrel (Method I).

(i) Set up a conspicuous aiming mark at the required distance.

(ii) Secure the moving arm of the Norman Vane sight so that the arm is horizontal and lies along the axis of the barrel.

(iii) Pull back the cocking handle and raise the safety catch; insert the barrel reflector and complete the harmonization as above.

NOTE.—Care should be taken not to move the gun until the adjustments are complete.

53. Detail of Procedure for a Lewis Gun Sighting through the Barrel (without the use of a Barrel Reflector) (Method II).

(i) Instead of inserting a barrel reflector remove the spade grip, bolt and piston rod, replace the bolt only so that the rear face of the feed arm actuating stud is flush with the rear end of the gun.

(ii) Place the head in such a position that the circle formed by the muzzle is concentric to that formed by the hole in the feed arm actuating stud.

(iii) Align the gun on the mark and continue as instructed in Metod I, paragraph 52.

NOTE.—The firing method of harmonizing sights on a Lewis gun is not practicable unless the gun be securely clamped so as to withstand the shock of firing. If this method is carried out, practically the same procedure as detailed in paragraph 52 should be used.

54. Checking Correctness of Harmonization.

Whenever possible, before flight commences, the harmonization should be checked by firing the gun at the butts, when the point of aim should coincide with the centre of the group, if the gun is fired at the fighting range. It must be realised that by no other method can so definite a check be obtained on the correctness or otherwise of the harmonization, if it is not possible to do this a visual method check should be carried out.

LECTURE No. 10.

55. Harmonization of Sights using a Limited Space.

Given :

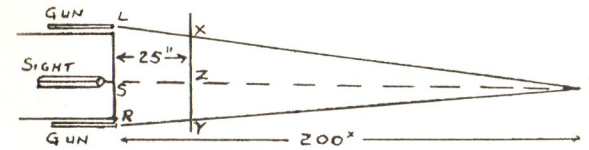
Maximum available range 25 yards.

Horizontal distance between left and right gun 5 feet.

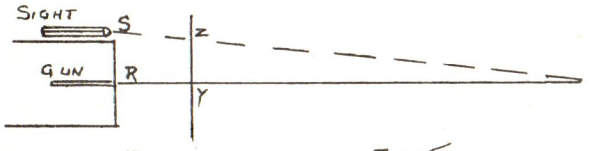
Vertical distance between sight and horizontal line joining the two guns 2 feet.

Required :

To harmonize sights for a range of 200 yards.



PLAN FIG I



ELEVATION FIG II

From the above it will be clear that if the line of sight and lines of fire are to coincide at 200 yards that the sighting points for guns and sight at 25 yards will be different and will have to be calculated.

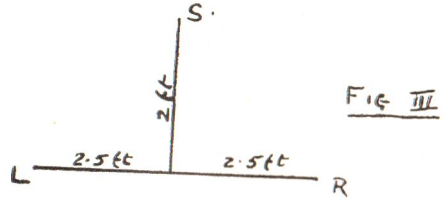


FIG III

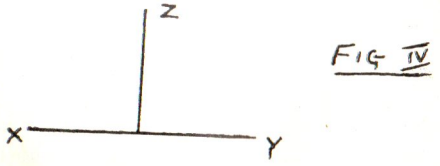
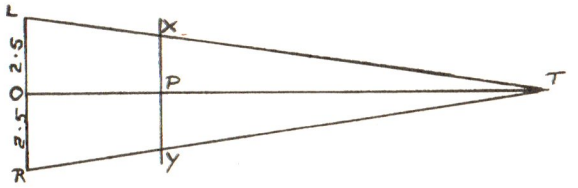


FIG IV

At the A/c the guns and sights appear on a vertical plane at LS and R with the distances as shown in Fig. III.

Seen from the pilot's seat at 25 yards the sighting points will appear as XZ and Y in Fig. 4. Z is on a vertical plane through the centre line of the A/C and X and Y on a horizontal plane passing through the two guns.



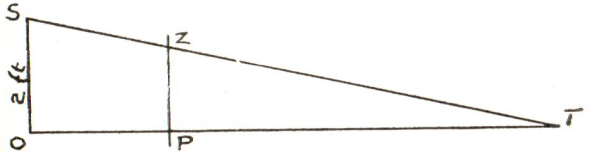
PLAN. FIG. V.

Triangles LOT and XPT are similar, therefore

$$XP = LO \times \frac{TP}{TO}$$

$$= \frac{2 \cdot 5 \times 525}{600}$$

$$= 2 \cdot 19 \text{ ft.}$$



ELEVATION. FIG. VI.

Triangles SOT and ZPT are similar, therefore

$$ZP = \frac{T\ P \times 50}{T\ O} = \frac{525 \times 2}{600}$$

$$= 1 \cdot 75 \text{ ft.}$$

1. Set the aircraft up in flying position.

2. Set up a large target at right angles to the fore and aft axis and at a distance of 25 yards from the A/c. On the target mark a point P in the horizontal plane in which the guns lie and on fore and aft axis of the aircraft produced. From point P draw a perpendicular line PZ 1·75 feet in length and also a horizontal line XPY, so that XP and PY are each 2·19 feet long.

8. *The Numerator.*—The numerator is attached to the right rear side of the body and the numbers can be seen through a small hole in top rear face of body cover.

58. The Moving Portions.

The moving portions consist of the following groups:

(i) *The Shutter Release Group.*—Consisting of:

(*a*) Shutter operating lever.
(*b*) Shutter release cable.
(*c*) Shutter release cable tension spring.
(*d*) Shutter release sear.

(ii) *Film Widing Mechanism.*—Consisting of:

(*a*) Mainspring housing.
(*b*) Connecting gear wheels.
(*c*) Chain and connecting rod.
(*d*) Sliding plunger notched to take the sear and to which is attached the cocking handle.

(iii) *Magazine Recording Mechanism.*—Consisting of:

(*a*) Magazine plunger housing.
(*b*) Plunger operating bar.
(*c*) Magazine plunger in front of magazine post.

59. Mechanism.

The mechanical processes which take place in the camera gun during its operation may be divided into two main parts.

(i) Those which take place when the cocking handle is drawn to the rear.

(ii) Those which take place when the cocking handle moves forward.

1. *Backward Movement*:

(*a*) *Winding the Film.*—When the cocking handle is drawn to the rear, the mainspring housing is rotated by the chain which is connected to the sliding plunger by the chain connecting rod. At the same time the intermediate gear wheels are revolved and cause the front gear wheel to rotate. This rotation winds the film from the upper to the lower spool, and thereby places a new piece of film opposite to the opening in the front film box.

(*b*) *Winding the Return Spring.*—The rotation of the mainspring housing puts tension on the return spring.

(*c*) *Action of the Numerator.*—The completion of the backward movement of the cocking handle draws the numerator operating stud and disc to the rear through one space.

(NOTE.—The numerator records the number of the film which is about to be exposed when the gun is cocked.)

(*d*) *Cocking Action of the Sliding Plunger.*—When the sliding plunger is fully drawn to the rear, it rides over the end of the sear and depresses it. Further backward movement of the sliding plunger allows the sear head to rise and to engage in the bent on the sliding plunger. Also as the sliding plunger is drawn to the rear, the shank of the cocking handle presses against the inclined end of the shutter release sear and raises it. When the shank of the cocking handle has completely passed, the shutter release spring exerts itself and depresses the sear.

2. *Forward Movement*:

(*a*) *Firing Action.*—When the trigger is pressed, the sear disengages from the bent in the sliding plunger, and the mainspring exerts itself. The plunger is then drawn forward by the chain and chain connecting rod.

(*b*) *Release of the Shutter.*—When the sliding plunger is released, it travels forward about $\frac{3}{32}$ of an inch when the shank of the cocking handle strikes the pointed portion of the shutter release sear, and causes the top of the sear to be drawn backwards. This action pulls the shutter release cable to the rear, rotates the shutter release lever and operates the shutter.

(*c*) *Action of the Recording Mechanism.*—When a magazine is placed on the magazine post, the under side of the magazine block forces the head of the magazine recording plunger down. The operating bar is now moved forward by the plunger lever and carries with it the needle-pointed plunger. The needle-pointed

plunger passes through the hole in the film carrier and punches a small hole in the film. At the end of the travel of the magazine plunger, the plunger operating bar slips downwards off the magazine plunger lever and allows the operating bar to return under influence of its spring.

LECTURE No. 13.

CARE AND MAINTENANCE.

60. General.

(i) The maintenance of the Camera Gun is the responsibility of the armament section of the unit. The assistance of the personnel in the photographic section will be obtained in maintaining the lens group. Spare parts will not be held in the units. When camera guns cannot be repaired with the resources available at the unit, the gun is to be returned.

(ii) The body of the gun should be cleaned daily by rubbing with an oily rag and must then be wiped clean with a dry rag.

(iii) The gun should be handled with care, and when fitted to aircraft, must not be allowed excessive freedom of movement when the aircraft is taking off, in flight, or landing.

(iv) Camera guns should be removed from aircraft immediately after use. cleaned as in sub-para. (ii) and placed in safe storage.

61. Spare Parts and Tools.

(i) The following spare parts are supplied in the gun transit case:—

(*a*) One set of shutter blades and screws.

(*b*) One set of gear wheels.

(ii) The following tools are supplied with the gun:—

(*a*) Lens reflector mirrors.

(*b*) Shutter release key.

62. Loading and Unloading the Gun.

(i) *General.*—The gun may be loaded or unloaded in daylight, provided that care is taken not to allow direct sunlight to reach the film on the film spools.

(ii) *To load the Gun*:

(*a*) See that the cocking handle is right forward.

(*b*) Open the door of the film box and remove the film carrier.

(*c*) Load the film carrier (see paragraph v).

(*d*) Replace the loaded film carrier with its metal back to the rear, and draw the cocking handle gently to the rear until the recess in the front gear wheel is opposite the lug in the rachet. The film carrier will then enter fully.

(*e*) Close the door of the film box.

(*f*) Set the numerator by pulling the knob of the numerator plate to the rear until the third dot past 14 is visable through the hole in the body cover.

(*g*) Draw the cocking handle fully to the rear and press the trigger.

(*h*) Repeat operation (*g*).

(*j*) The gun is now loaded, and the numerator will show the figure " 0 ".

(iii) *To Cock the Gun.*—Draw back the cocking handle fully to the rear. Care must be taken that the cocking handle is fully back otherwise the shutter is not set and the gun cannot be fired.

(iv) *To Fire the Gun*:

(*a*) Press the trigger.

(*b*) The number shown in the numerator window of the body cover when the cocking handle is forward indicates the number of exposures that have been made.

(v) *To load the Film Carrier*:

(*a*) Break the sealing band of the spool.

(*b*) Place the spool in the carrier with the free end of the spool paper leading under the roller towards the ratchet end of the carrier.

(*c*) Close the retaining lug over the spool.

(*d*) Place an empty spool in the ratchet end of the carrier and connect the free end of the film to it.

(*e*) Rotate the spool at the ratchet end of the carrier until a portion of brown paper is visible from the new spool. Do not wind any further.

(*f*) The film carrier is now loaded and is ready for insertion in the gun.

(vi) *To Unload an Exposed Film:*

(*a*) The cocking handle should be drawn to the rear and the trigger pressed. This operation should be repeated at least three times.

(*b*) The film box should be opened.

(*c*) The film box should be lifted out.

(*d*) The gummed paper strip which is found adhering to the protecting paper should be moistened and secured round the spool to prevent the paper from unwinding.

63. Sights for Aircraft Gun (Type C.3).

It is unnecessary to make allowance for " own speed " and time of flight of the bullet, either when firing ahead or at any angle to the line of flight. The theory detailed in paragraphs 1-20 is otherwise equally applicable to the use of the camera gun sights, and targets are positioned in an exactly similar manner in the ring of the sights of the Camera Gun Type G. 3 as they are with fixed and free gun sighting systems.

64. Description.

(i) The sighting system is composed of the following parts:—

(ii) The ring sight:

(*a*) The outer ring made of steel is 2·5 inches in internal diameter.

(*b*) The sight stem has an overall length of 4 inches. The upper end is flanged to provide an attachment for the outer ring, and above the flange the stem becomes smaller and tapers to the inner ring.

(*c*) The inner ring is concentric with the outer ring, and it has an external diameter of $\frac{3}{8}$ inch.

(iii) The ring sight mounting consists of two " C " shaped brass castings which are hinged together at one side and fastened together on the opposite side by a bolt and nut.

(iv) The fore-sight.

(a) The fore-hight stem is $5\frac{1}{4}$ inches in length. Upper end has a small spherical ball of $^{3}/_{16}$ inch diameter.

(b) The foresight mounting is a circular brass casting.

(v) Length of sight base is 20 inches.

(vi) Position of the fore-hight. The exact distance of the foresight from the ring is immaterial.

(vii) Supply. The gun is supplied complete with one set of sights and sight mountings.

65. Detail of Procedure for Harmonization.

(i) Set up a conspicuous aiming mark.

(ii) Open the film box and remove the film carrier.

(iii) Insert the lens reflector mirror.

(iv) Open the shutter by means of the shutter release key.

(v) By means of the lens reflector mirror align the gun so that the aiming mark is in the centre of the graticule screen.

(vi) Align the sights to coincide with this mark.

(vii) Upset the aim of the gun and repeat sub-paragraphs (v) and (vi).

66. Care and Maintenance of the Sights.

(i) All personnel should be warned not to interfere with the sights either as regards position or setting.

(ii) Sights should always be harmonized before use.

(iii) Sights should be cleaned daily with an oily rag, and then be rubbed dry with a clean one.

(iv) Minor repairs should be carried out by the armament personnel, but if the sight is seriously damaged it should be returned to store, with a label attached stating the nature of the defect, and a new sight should be fitted and harmonized.

LECTURE No. 14.

PRACTICAL SIGHTING.

Firing at a model aircraft with the Camera Gun.

LECTURE No. 15.

PRACTICAL SIGHTING.

Firing at an aircraft in flight from the ground with the Camera Gun.

LECTURE No. 16.

PRACTICAL SIGHTING.

Marking and Criticising Camera Gun Films.
(Ref. A.P. Chapter .)

LECTURE No. 17.

GUN MOUNTINGS.

67. Gun Mountings.

Introduction.—The mounting of free guns on aircraft proved a difficult problem during the war. A remarkably efficient mounting was developed by W/O Scarff, R.N.A.S., and this was adopted as standard equipment. In a modified form this mounting is still extensively used.

Quite a crop of "high-speed" mountings has appeared during the past few years, the best examples being the Fairey, Hawker, Avro and the improved type of Vickers-Armstrong.

The old type caused a serious drop in the performance of fast aircraft but the Fairey mounting permits the use of an aerodynamically efficient cock-pit hooding, and the gun, when not in use, is stowed away in the fairing.

68. Positioning.

Gunner's positions in aircraft capable of speeds in excess of about 180 m.p.h. demand special attention.

Many interesting features have been designed to protect the gunner from the air pressure when flying at these high speeds and enable him to use his gun freely and efficiently. Retractable and rotatable gun turrets have been developed to procure the best possible fields of fire for defence purposes in multi-engined aircraft, the usual positions being in the nose, in the stern and beneath the fuselage.

69. General Remarks.

Aircraft gun mountings may be classified under two main headings:—

(*a*) those for fixed guns;
(*b*) those for free guns.

The only points which are common to both are:—

(*a*) they must be able to minimise the "jump" of the gun, and,

(*b*) they must be light, in spite of the strength necessary.

1. *Jump.*—Mountings must be stiff enough to hold the gun steady during its operation so that the group fired is as small as possible.

When a gun is fired from a mounting, the members comprising the mounting give elasticity, and the bullet, in consequence, does not reach the target at the point it would do if the mounting was quite rigid. The amount of angular deflection so produced is called the "jump" of the mounting and mountings are designed to reduce this jump to an absolute minimum.

2. *Lightness*:—

(*a*) It is essential that weight in A/c fittings be reduced to a minimum, combined with maximum strength. In pursuance of this object, fixed gun mountings incorporate, as a portion of the mounting, part of the normal structure of the A/c, and it is, in fact, in some types rather difficult to differentiate where the mounting ends and the bracing system of the A/c commences.

(*b*) As regards free gun mountings the design of the mounting is not integral with the A/c and is of necessity a completely separate component issued as a separate store.

70. Fixed Gun Mountings.

1. The primary object of this type of mounting is to hold the gun rigidly in a certain definite relation to the other component parts of the A/c.

2. As has been explained in paragraph 69 (2), it is possible to build this type of mounting into the design of the A/c. As the force of recoil of the Vickers gun is relatively small, these mountings need not be very massive, but should fulfil the requirements of extreme rigidity.

3. Fixed mountings are so arranged that it is possible to adjust the alignment of the gun in both the vertical and horizontal planes to a slight extent. The adjustment is retained even in single gun a/c as it enables the gun to be aligned parallel to the line of flight if the original alignment is disturbed in re-rigging.

4. The supply of ammunition to a gun under these circumstances is best carried out by means of a belt. This method needs no more than casual observation from the gunner and no manual manipulation is required to bring the gun into action once it has been loaded. The service ·303 inch guns at present in use are the Vickers and Browning guns which are both belt fed.

5. In the design and construction of service a/c, provision is made to mitigate the effect of muzzle blast on the a/c structure near the line of fire. Where possible all cowling is kept well clear of the line of fire, but when this is impossible, steel stiffening plates are fitted to strengthen the cowling locally against the effect of blast pressure.

6. Description and illustrations of the fixed gun mountings, which are not in universal use, are shown in the handbook applicable to each particular type of aeroplane and reference should be made to these.

71. Free Gun Mountings.

1. The essential requirement of this type of mounting is that it must be possible to move the gun through as wide an arc as possible, thus fire over a large field is possible, from the gunner's position.

2. The following difficulties arise:—

(*a*) The slipstream acting on the gun prevents it being moved readily from one position to another.

(*b*) The supply of ammunition to the gun.

(*c*) There must be no restrictions in the movement of the gun.

3. The force of the slipstream may be overcome by some mechanical device, such as is used in the No. VII Scarff Ring.

4. The supply of ammunition to the gun necessitates the use of a gun fed by some means, which does not create an excessive head resistance. The service ·303 inch free guns at the present time in use are the Lewis and Vickers "K" guns, which are magazine fed. The magazine is "pan" shaped and is attached to the gun in such a manner as to offer comparatively small head resistance.

5. The fact that there must be no restriction in the movement of the gun implies that the mounting must be easily operated manually even at high altitudes when the gunner's strength is reduced.

6. The field of fire is, in most types of a/c, restricted by their construction, and to overcome this and to ensure the elimination of "blind spots," various a/c are fitted with several gun positions, so that as far as possible all round attack and defence may be obtained.

72. Ring, Scarff, No. 7.

General Details:—

(i) Nomenclature—Mountings Machine Gun Scarff Ring No. 7 (i).

(ii) Weight 32½ lbs.

(iii) External diameter of the fixed ring: 33 inches.

(iv) Method of balancing the elevating arm: 2 elastic cords.

(v) Method of balancing slipstream forces: Compression spring.

(vi) Materials used:—

(*a*) Traversing and anchorage rings (aluminium).

(*b*) Pulleys and bow anchorage (aluminium).

(*c*) Mounting yoke (gun metal).

(*d*) The remainder (steel).

(vii) Spring pressures:—

(i) Light.

(ii) Medium.

(iii) Heavy.

73. Description.

It consists of a rotating ring carrying ten vertical and ten horizontal rollers which run on a second ring fixed to the cockpit decking. Both rings are aluminium silicon castings. The rotating ring is formed with a varying depth of section so that its bottom surface provides a cam contour on which run two spring-loaded rollers. The rollers are deflected to their lowest positions and the spring is consequently fully compressed when the gun is in its aftermost position, and the cam contour is so formed that as the gun ring is rotated either way from due aft the rollers exert on it a progressively greater deflecting force which serves to balance the air forces on the gun due to the slipstream. The adjustment of the spring tension should not be interfered with as a very small reduction in its effective length would cause blocking of the spring and consequent failure of the tension rod.

74. The gun elevating gear consists of a tubular steel arch hinged to the rotating ring and located in the desired position by stop pins engaging with quadrants. The stop pins are actuated by the normal type of lever on the arch through Bowden wires to a cam and tappet mechanism which also operates the locking pins for the rotating ring. The weight of the gun is balanced by elastic cord loops. The ammunition is carried in six Mk. II No. 2 magazines (97 rounds), five of the magazines being accommodated on pegs in the rear cockpit and the remaining one on the gun.

LECTURES Nos. 19 AND 20.

PRACTICAL.

LECTURE No. 18.

REVISION.

No. 134

South African Air Force Standard Notes

ARMAMENT
Section "G"

CHAPTER III

MACHINE GUN SYNCHRONISING GEAR

Printed in the Union of South Africa by the Government Printer, Pretoria
1939

G.P.S. 1843—1939—1,000.

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ARMAMENT SECTION "C".

CHAPTER III.

MACHINE GUN SYNCHRONISING GEAR Mk. II.

SYLLABUS.

10 *LECTURES.*
($\frac{3}{4}$ *HOUR each.*)

1. *Classroom Instruction.*	*Lecture.*	*Page.*
(*a*) Basic principles of the Gear and General description of Parts.....	1	1 to 3
(*b*) Filling of the Gear Mechanism....	2 and 3	4 to 8
(*c*) Timing the cam Gear.....	4 and 5	9 to 11
(*d*) Ground Testing and Timing Disc..	6	12 to 13
(*e*) Fitting Trigger motors and bowden cables and general repairs.....	7	14 to 17
(*f*) Four stoppages and remedies.....	8	18 to 19
(*g*) Practical demonstration of filling and timing cams and stop butt tests and general revision.....	9 and 10	—

ARMAMENT SECTION "G".

CHAPTER III.

MACHINE GUN SYNCHRONISING GEAR Mk. II.

INSTRUCTIONAL EQUIPMENT.

(*a*) C. C. Gear mounted on a board with all the main features sectioned (Twin Gun Installation).

(*b*) Indicators cam position C. C. Gear Ref. I E/5062.

MACHINE GUN SYNCHRONISING GEAR, MARK II.

Definition.

The machine gun synchronising gear is a device by means of which a gun may be fired through the plane of rotation of an airscrew, without the bullets striking the blades.

Basic Principles of the Gear.

The operation of the gear depends upon the fact that an impulse, when applied at one end of a column of liquid under pressure in a pipe line, is transmitted at high velocity along the column and reproduced at the other end practically unchanged.

In the M.G. synchronising gear the impulse is applied to the column of liquid by a plunger, operated by a cam wheel. This "plunger" is known as the generator. The impulse, after travelling to the end of the main pipe line, acts against a second plunger, contained in a suitable housing mounted on the gun. This is known as the trigger motor.

To provide the necessary supply of oil under high pressure and its return to low pressure without loss of liquid, a mechanical arrangement consisting of piston, cylinders and ball valve gear is connected to the pipe lines. This apparatus is known as the reservoir.

To facilitate the removal of air from the liquid under varying conditions of air density and temperatures at different heights, a "release valve" is incorporated in the pipe lines system. This is known as the air release valve.

Finally, to provide a convenient optional control of the gear from the pilot's cockpit, a remote control is connected from the firing lever on the control column in the pilot's cockpit to the reservoir.

General Description.

The gear consists of seven main components:—

(*a*) The reservoir unit.

(*b*) The secondary pipe line.

(*c*) The trigger motor unit.

(*d*) The main pipe line.
(*e*) The generator unit.
(*f*) The air release valve and pipe lines.
(*g*) The Bowden controls.

Nomenclature of Parts.

The Low Pressure Reservoir :—

(*a*) Filler cup.
(*b*) Filler cap.
(*c*) End cap.
(*d*) Low pressure filter ring.

High Pressure Piston Rod :—

(*a*) Upper anchorage.
(*b*) Cup packings.
(*c*) Cup packing retaining ring.
(*d*) Cup packing retaining nut.
(*e*) High pressure piston rod spring.
(*f*) Reservoir handle, nut and pin.

Reservoir Base :—

(*a*) High pressure reservoir.
(*b*) High pressure passages.
(*c*) High pressure ball valve chambers.
(*d*) High pressure balls.
(*e*) High pressure ball valve springs and plungers.
(*f*) High pressure ball valve plugs.
(*g*) Low pressure passages.
(*h*) Low pressure ball valve chambers.
(*i*) Low pressure balls.
(*j*) Low pressure ball valve plugs.
(*k*) Low pressure ball valve glands.
(*l*) Low pressure ball valve washers.
(*m*) Low pressure ball valve locking nuts.
(*n*) Control needles.
(*o*) Control needle levers and return springs.
(*p*) Control needle lever bracket.
(*q*) Low pressure ball valve locking nut spring.
(*r*) Ball valve chambers connecting passages, with seatings for high pressure and low pressure balls.
(*s*) Ball valve needles.
(*t*) Secondary pipe line ports.
(*u*) High pressure filter plug.
(*v*) Control needle cover and screws.

Trigger Motor, Mark II :—

Tee Piece, which contains :

(*a*) Tee piece connector.
(*b*) Damping valve.
(*c*) Damping valve spring.
(*d*) Tail piece and union nut.
(*e*) *Plunger guide.*
(*f*) Plunger.
(*g*) U-Packing washer, and
(*h*) U-Packing ring.
(*i*) *Trigger motor body.*
(*j*) Trigger motor push rod.
(*k*) Push rod guide.
(*l*) Trigger motor spring.
(*m*) Trigger motor cap and spring.
(*n*) *Trigger motor bracket.*
(*o*) Trigger motor adjustment plates.
(*p*) Trigger motor adjustment screw.
(*q*) Bush and split pin.
(*r*) Nuts and bolts (4).

Generator, Mk. I, Special, consists of :—

(*a*) Generator body.
(*b*) Generator piston.
(*c*) Generator piston roller and axis pin.
(*d*) Generator piston cup packing ring.
(*e*) Generator piston cup packings (2).
(*f*) Generator piston cup packing nut and split pin.
(*g*) Generator lock nut and locking wire.

Generator, Mk. II :—

(*a*) Generator body.
(*b*) Generator piston.
(*c*) Generator piston roller and axis pin.
(*d*) Generator piston cup packing ring.
(*e*) Generator piston cup packings.
(*f*) Generator piston cup packing nut and securing wire.
(*g*) Generator piston return spring, saddle and cotter.
(*h*) Generator lock nut.

Air Release Valve consists of :—

(*a*) Air release valve body.
(*b*) Air release valve needle.

(*c*) Thumb wheel.
(*d*) Air release valve union nut and packing.
(*e*) Air release valve pipe line, Part I.
(*f*) Air release valve pipe line, Part II.

Main Pipe Lines.
Secondary Pipe Lines, Parts I and II.
Bowden Controls.

Filling.

Mixtures Used:—

Normal Conditions (Summer):

10 per cent. by volume, oil lubricating, G.P., Thin.
90 per cent. by volume, paraffin.

Extreme Low Temperature Conditions (Winter):

10 per cent. by volume, oil, anti-freezing.
90 per cent. by volume, paraffin.

After mixing the oil, strain through a fine mesh gauze and store in a clean container.

In order to fill the low pressure reservoir a suitable filling can should be adapted and kept solely for that use.

To Fill the Gear:—

1. Open the air release valve fully.
2. Fill up the low pressure reservoir.
3. Pull up the high pressure piston rod to top of its stroke.
4. Press fire control (Bowden) lever.
5. Repeat 3 and 4 twice and again fill up low pressure reservoir.

   NOTE.—Pressure must be removed from the firing lever when pulling up high pressure piston rod.
6. Repeat 5 until the liquid, free from air bubbles, is seen to flow from the secondary pipe line into the filler cup of the low pressure reservoir.
7. Repeat 3 and 4 and whilst high pressure piston rod is still falling, close air release valve.

8. Repeat 3 and 4; the high pressure piston rod should fall slightly and remain stationary.
9. Loosen trigger motor union nut slightly, press fire control lever and tighten union nut whilst high pressure piston rod is still falling.
10. Loosen generator union nut, press fire control lever and tighten union nut whilst high pressure piston rod is falling.
11. Again fill up low pressure reservoir, open air release valve, press fire control lever and close air release valve.

Test After Filling.—If the gear has been correctly filled, and all air expelled from the system, the high pressure piston rod, each time the fire control lever is pressed, will fall rapidly a short distance and then remain stationary.

Mechanism.

In order that the action may be more easily understood, consider the gear correctly filled and in the following positions:—

1. At rest, but not ready for firing.
2. Ready for firing.
3. During firing.
4. Firing action.
5. After firing.

1. *At Rest, but Not Ready for Firing.*—(*a*) The high pressure piston rod is in its lowest position; there is, therefore, no pressure in the high pressure reservoir. The control needle, under the influence of control needle return spring, is held out of contact with the low pressure ball. The high pressure ball is held on its seating by the high pressure ball valve spring. The ball valve chamber connecting passage and has taken up a position towards the low pressure ball valve chamber. Any pressure in the system is, therefore, free to pass through the secondary pipe line and escape past the flutes of the needle, through the low pressure ball valve chamber into the low pressure reservoir.

(*b*) The generator piston is out of engagement with the cam wheel.

(*c*) The trigger motor push rod is held in its normal position by the trigger motor push rod spring.

(*d*) The damping valve is held on its seating by the damping valve spring.

(*e*) The air release valve is closed.

2. *Ready for Firing.*—The high pressure piston rod is pulled to the top of its stroke, which extends the high pressure piston rod spring and causes a partial vacuum in the high pressure reservoir. When the high pressure piston rod reaches this position the oil in the low pressure reservoir enters through the space between the high pressure piston rod cup packings and the bell-mouth of the high pressure reservoir to fill the high pressure reservoir.

When the high pressure piston rod is released, the H.P.P.R. spring forces the cup packings against the column of oil trapped in the high pressure reservoir, placing it under high pressure. The oil is prevented from escaping to the pipe lines as the high pressure ball is still firmly held on its seating by the high pressure ball valve spring.

The remainder of the gear is therefore still in the "At Rest, but Not Ready for Firing" position.

3. *During Firing (Action of the H.P. Oil).*—When the fire control lever is pressed, the control needle lever forces the control needle into the low pressure ball valve chamber, compressing the control needle lever return spring. The control needle forces the low pressure ball on to its seating, causing the L.P. ball to bear against the ball valve needle forcing it along the connecting passage and lifting the H.P. ball off its seating, compressing the H.P.B.V. spring. This allows the oil under pressure to pass through the H.P. filter and H.P.B.V. chamber, along the flutes of the B.V. needle, into the secondary pipe line.

The H.P. oil is prevented from escaping into the L.P. reservoir by the L.P. ball being held on its seating.

The pressure in the pipe lines is thus raised to that existing in the H.P. reservoir. This pressure is exerted through the secondary pipe line, into the trigger motor, through the hole in the damping valve, along the main pipe line to the generator. The generator piston is then forced outwards against the cam wheel, the roller remaining in contact with it throughout its rotation. This pressure, though applied to the trigger motor, is insufficient to operate the trigger motor push rod.

As the air release valve is closed, the pressure thus built up in the pipe lines cannot escape back to the L.P. reservoir.

4. *Firing Action.*—As the cam wheel rotates the generator piston roller being brought into sudden contact with the cam causes the generator to be subjected to a sudden "lift". This lift is transmitted to the column of oil in the pipe lines, the resultant effect being an "impulse" or "wave" of high velocity being generated and passed through the main and secondary pipe lines.

In the main pipe line, the damping valve is lifted off its seating, the trigger motor plunger is forced against the head of the trigger motor push rod, forcing it outwards through its guide.

The effect in the secondary pipe line is unimportant, merely causing a slight oscillation of the H.P.P.R., which has no effect on the action of the firing control.

In order to ensure that the gun is not fired when the engine is running slowly, wherein the possibility of a late shot striking the airscrew blade may occur, a form of safety device is incorporated in the gear.

This is arranged in the trigger motor and is effected by the inlet port in the tail piece being reduced to dimension considerably less than the head of the plunger, so that only a portion of the surface area of the plunger head is exposed to the incoming impulse until the plunger is forced clear of the port.

Vickers Gun.—After being forced outward through the push rod guide, the trigger motor push rod is then in such a position as to either trip the trigger of the lock or to trip the trigger as the lock comes forward on the completion of the forward movement of the recoiling portions, thus firing the gun.

Browning Gun.—The inner end of the push rod will either strike the lower lug of the sear and disconnect the sear from the firing pin, or the push rod may be swung forward by the sear as the breach block goes forward. If this is the case then the trigger motor spring returns the push rod to its housing. The trigger motor push rod plunger repositions the push rod and the successive impulse operates the sear by direct action of the push rod and thus fires the gun.

Dissipation of the H.P. Impulses or Waves.—The trigger motor spring returns the push rod and plunger to their normal positions and the rebounding impulse is dissipated by being " damped " out through the small central hole of the damping valve, which is now firmly on its seating.

Protrusion of Generator Piston.—During the whole time that pressure is maintained on the fire control lever, the generator piston remains under pressure from the H.P. reservoir. The piston roller is thereby kept in contact with the cam wheel, so that it will be in position to be subjected to each successive " lift " from the cams.

5. *After Firing.*—When the fire control lever is released, the control needle lever return spring exerts itself, causing the control needle to be withdrawn from the L.P. ball, thus releasing it from its seating.

The H.P.B.V. spring is then allowed to return the H.P. ball to its seating which, in turn, forces the B.V. needle along its passage towards the L.P.B.V. chamber.

This action closes the H.P. port and prevents further discharge of H.P. oil from the reservoir into the pipe lines and also permits the release of resident pressure from the pipe lines into the L.P. reservoir.

This release of pressure is effected by the subsequent stroke of the generator piston when the pressure wave, on reaching the needle wave, carries the valve towards the L.P.B.V. chamber, thus opening the port to allow the escape of oil to the L.P. reservoir.

By this means the pressure in the system is again reduced to that existing in the L.P. reservoir and the generator piston is forced away and remains out of contact with the cam wheel.

The sequence of operation of the gear is now complete and the gear is again in the " Ready for Firing " position.

Timing.

Defintion.—Timing is the correct positioning of the airscrew blade, relative to the axis of the bore of the gun, at the moment the impulse which fires the gun is generated.

General Remark.—(*a*) The M.G. synchronising gear should only fire the gun at certain predetermined positions of the airscrew blade, which can be obtained from either the appropriate aircraft handbook or other official source.

(*b*) The timing position for any particular gun installation, however, depends upon:—

(i) The length of the main pipe line;

(ii) The distance of gun from plane of rotation of the airscrew, and

(iii) The range of speeds of the engine.

General Procedure when " Timing ".—Two methods are used, dependent upon whether the cam gear is readily visible or not.

1. *When Cam Gear is Readily Visible (Twin Gun Installation):*—

(*a*) Clean and dry out the barrels of the guns.

(*b*) Ascertain the " timing " position of airscrew.

(*c*) Ascertain direction of rotation of airscrew and cam wheels.

(*d*) Trace the generators to their respective guns by means of the pipe lines.

(*e*) Open up the cam gear box and select the gun which is operated by inner cam to be timed first (as No. 1 gun).

(*f*) Rotate the airscrew in its normal direction of rotation to its correct position in relation to the barrel of the gun.

(*g*) Adjust the position of the cam wheel on its shaft so that the " peak " of one cam is coincident with the centre line of the generator piston and roller, i.e. at the point where maximum " lift " occurs and with the generator at " full stroke ".

(*h*) To check for the correct location of the second cam on the wheel, rotate the airscrew through 180° to bring the second blade to the correct position in relation to the barrel of No. 1 Gun. The check that the peak of the cam is again coincident with the generator piston as laid down in (*g*).

(*i*) Having satisfactorily completed No. 1 Gun, follow the same procedure for No. 2 Gun. Care must be taken when adjusting the position of the outside cam wheel for No. 2 Gun not to alter the position of the inner cam wheel.

(*j*) Lock the cam gear assembly securely and check the timing of each gun carefully as laid down in (*f*) and (*g*).

NOTE.—The " Indicator, Cam Positioning " may, if required, be used to check the equality of the lifts of each cam, and in checking the timing.

2. *When Cam Gear is Not Readily Visible (Twin Gun Installation)* :—

(*a*) Proceed as for (*a*), (*b*), (*c*), and (*d*) in aparagraph 1.

(*b*) Disconnect pipe lines from generator at generator union.

(*c*) Assemble the cam positioning indicator firmly to the generator operating the inner cam (No. 1 Gun) so that the dial is visible.

(*d*) Test for equal lift by both cams on cam wheel by first setting the needle and marker to zero. Then turn airscrew slowly in direction of normal rotation until needle and marker register maximum lift by the first cam. Continue rotation through 180° and observe if the needle again coincides with marker. (If large variation of lift is indicated it may be necessary to replace cam wheel.)

(*e*) Rotate the airscrew in the normal direction of rotation until the cam operates the generator piston to bring the " needle " coincident with " marker " on the position indicator.

(*f*) Ascertain the position of the airscrew in relation to the barrel of the gun. If the cam is operating early or late alter the position of the cam wheel the estimated amount to correct.

(*g*) Repeat (*e*) and (*f*) until the " needle " again coincides with the " marker " on positioning indicator and the airscrew, in its correct " timing " position is coincident with the barrel of the gun.

(*h*) Repeat (*e*), (*f*) and (*g*) for outer cam wheel (No. 2 gun).

(*i*) Lock cam assembly securely.

NOTE.—On completion of Timing No. 2 Gun, a check timing for No. 1 Gun should again be carried out owing to the possibility of the alteration of the inner cam wheel when adjusting the outer.

Ground Testing.

1. Ground testing of the gear is always to be carried out : —

(*a*) After timing and before stop butt test.
(*b*) Before air firing.
(*c*) After repair or failure of the gear.

2. The gear should respond to the tests enumerated below : —

(i) Pull up the H.P.P.R.....	The H.P.P.R. should fall slightly and remain steady.
(ii) With the Air Release Valve closed, press fire control lever No. 1 Gun	The H.P.P.R. should fall a short distance and remain steady.
(iii) Repeat for No. 2 Gun.....	As for No. 1 Gun.
(iv) Ensure that No. 1 Gun is is unloaded by operating crank handle ; run engine at half maximum r.p.m. ; press fire control lever No. 1 Gun	The trigger motor push rod should trip the trigger of the lock immediately fire control lever is pressed.
(v) Release fire control Lever..	Trigger motor push rod should cease to operate immediately pressure is removed from fire control lever.
(vi) Repeat (iv) and (v) for No. 2 Gun	

The Timing Disc.

The " Timing Disc " is used for the following purposes : —

(*a*) Test for accuracy of timing after installation of gear on new type aircraft for which the timing position has not been authorised.

(*b*) For the investigation of airscrews " holed " during air firing, to test correctness of operation of gear and gun.

The disc should be manufactured locally to the particular requirements of the aircraft with which the unit is equipped.

It should be fitted to the airscrew so that when the gun is fired, the path of the bullets in relation to the blades of the airscrew is recorded.

The details of fitting, method of carrying out firing with the disc and recording of information are contained in A.P. 1242, Chapter 9, paras. 30 to 39.

The action to be taken when airscrews are holed during air firing is laid down in A.P. 1242, Chapter 9, para. 60.

Method of Fitting the Trigger Motor on Vickers Gun.

1. Detach trigger motor body from bracket by removing the bush and split pin.

2. Strip, clean, examine, and assemble the trigger motor body and tee piece.

3. Remove feed block from gun.

4. Remove adjusting screw from bracket; place bracket on front cover of gun and join bracket to anchorage by screwing in the " adjusting screw " evenly to approximately half the length of each thread.

5. Insert the securing bolts and secure nuts finger tight.

6. Assemble body to bracket by means of bush and split pin.

7. Insert the lock in the gun.

8. Adjust clearance between the end of the push rod and the face of the tail of the trigger by inserting ·5 mm. (·02 inch) feeler gauge, and rotating adjusting screw.

9. Tighten up the nuts of the bracket securing bolts.

10. Disconnect the tail piece from the body and remove plunger guide. Test protrusion of push rod by forcing it through the guide against the tail of the trigger. The minimum further protrusion *after* trigger is tripped should be 1 mm. (·039 inch) approximately).

11. Ensure that positive engagement of the end of the push rod with the tail of the trigger occurs.

12. Ensure that the push rod does not foul the cover axis pin in its protrusion. If either the push rod guide or push rod foul the cover axis pin, suitable sheet metal packing should be inserted under the trigger motor. On no account is metal to be removed from either the guide, push rod or axis pin.

13. After inserting packet, repeat all procedure laid down.

14. With the push rod fully extended, operate the crank handle and ensure that the push rod does not foul the lock casing or loop of the lock spring.

15. Remove lock from gun; reduce the length of the securing bolts and burr over to lock.

16. Insert split pin through adjusting screw and front cover of gun, ensuring splayed out ends do not interfere with feed block mechanism.

Tests to be carried out.

(*a*) After fitting;

(*b*) During inspection.

(i) Remove the tee piece, plunger guide, push rod and push rod spring.

(ii) Oil the push rod lightly and replace in guide.

(iii) Test for free movement of the push rod in all positions by moving it up and down and rotating it at the same time.

(iv) Assemble the trigger motor; tighten plunger guide and tee piece union nut.

(v) Test clearance between end of push rod and tail of the trigger.

Fitting (Bowden) Fire Control Cable.

1. Screw in adjuster to its limit to allow maximum length of inner cable.

2. Instal cable in accordance with maker's installation.

3. All bends must be easy to eliminate tendency to restrict free movement of the inner cable inside the casing.

4. Secure cable at intervals with pliable metal clips so that no possible obstruction occurs to aircraft controls. (Request pilot to operate aircraft controls to full extent as a check.)

5. Adjust (by means of adjuster) the effective length of the cable so that the gun fires before the limit of travel of the firing lever, and ceases to fire immediately the lever is released. (This adjustment must first be carried out in the hanger, observing the action of the H.P.P.R. as the indication of the firing of the gun. Final tests must be, however, carried out with the engine running and the pilot of the aircraft operating the gun control before the aircraft is taken to the stop butt.)

6. Ensure that adjuster lock nut is secure.

Repairs and Adjustments.

Repairs:

The extent to which repairs to the gear by armourers in units, other than repair depots, may be carried out is as follows:—

(i) Pipe lines—no repairs to be carried out.
(ii) Reservoirs—may be stripped for cleaning and the replacement of cup packings and washers only.
(iii) Trigger motor—may be stripped for cleaning and replacement of cup packings.
(iv) Generators—replacement of cup packings only.
(v) Air release valve—new packing fitted only.
(vi) Fire control cable—replaced by new cable if available, or new cable to be made up.

If an assembly, e.g., trigger motor or reservoir, becomes unserviceable and the defect cannot be traced and remedied by the permissible repair, it is to be returned to the Repair Depot.

To Replace H.P.P.R. Cup Packings:

1. Remove reservoir from aircraft and empty.
2. Pull up H.P.P.R. and insert the lowering tool pin.
3. Drift out taper pin, remove nut and handle.
4. Attach the lower tool to the H.P.P.R. fit handle and nut.

5. Remove H.P. filter plug.
6. Raise H.P.P.R., remove pin and lower H.P.P.R. through base.
7. Replace cup packing, coat with anti-freezing oil, and assemble.

To assemble, reverse the order.

To Replace Generator Cup Packing

(Mks. I. and II. Generators):—

1. Disconnect generator union nut—use two spanners to avoid distortion.
2. Remove locking wire and lock nut and generator from bracket or cam box. (This procedure varies with types of A/C.)
3. Withdraw piston, and replace defective cup packings.

To assemble reverse the above order.

To Replace Trigger Motor "U" Packings:—

1. Remove trigger motor from gun.
2. Remove T.M. tail piece and plunger guide.
3. Remove plunger and "U" packing ring.
4. Remove defective leather packing (using tools, wad).
5. Insert new packing and assemble in reverse order, taking care to avoid damage to channel in plunger guide.

To Replace L.P.B.V. Washer:

1. Remove control needle lever axis pin, spring and lever.
2. Withdraw control needle.
3. Remove L.P.B.V. locking nut, L.P.B.V. plug, and L.P. ball
4. Remove defective washer and replace, ensuring that "gland" is in position.

To assemble:—

(*a*) Assemble the L.P.B.V. plug and locking nut.

(*b*) Insert the control needle in position and place the L.P. ball in the recess of the plug.

(*c*) Hold the reservoir with the L.P.B.V. chamber downwards and without displacing the ball, screw in the assembled valve.

NOTE.—Unless this operation is carefully carried out, the L.P. ball may become trapped between the plug and the face of the chamber.

To Renew Packing in A.R. Valve:—

1. Unscrew union nut and remove valve spindle.
2. Prepare a short length of asbestos string coated with graphite and oil.
3. Coil about 3½-4 turns clockwise round spindle insert valve and screw on union nut.

Faults and Failures.

The failure of the gear is usually indicated by the behaviour of the H.P.P.R. Reference to the position of this will assist in investigating the failure and ascertaining the cause.

FAULTS TABLE.

Fault No.	Notification.	Action.	Fault.	Repair.
1.	After pulling up H.P.P.R. to top of stroke, it sinks SLOWLY without operation of either fire control lever.	(*a*) Inspect H.P. Ball Valve Plug and H.P. Filter Plug for leakage. (*b*) Press the fire control levers right home ONE AT A TIME. If, when one lever is operated, the H.P.P.R. remains steady. (*c*) If, when both fire control levers have been pressed right home, H.P.P.R. continues to sink.	(*a*) Leakage at Plugs. (*b*) Defective H.P. Ball valve or Valve Seating. (*c*) Damaged H.P.P.R. Cup Packings.	(*a*) As found necessary on inspection. (*b*) 1. Strip, clean and re-test Valve. 2. Return assembly to stores. (*c*) Fit Cup Packings. ..
2.	After pulling H.P.P.R. to top of stroke, it REMAINS STEADY; but on pressing the Fire Control levers one at a time, sinks slowly to the bottom.	(*a*) Pull H.P.P.R. to the top of stroke. Fill L.P. reservoir. Press fire control levers fully home, separately. Mixture overflows at filler cup. (*b*) Mixture does not overflow at filler cup.	(*a*) Defective L.P. Ball Valve. (*b*) Leakage at some part external to reservoir base.	(*a*) As for 1 (*b*), 1 and 2. (*b*) As found on inspection.

FAULTS TABLES.—(contd.).

Fault No.	Notification.	Action.	Fault.	Repair.
3.	After pulling H.P.P.R. to top of stroke it remains steady, but when one fire control lever is pressed nearly home the H.P.P.R. sinks continually.	(a) Press fire control lever right home. H.P.P.R. remains steady.	(a) 1. Damaged Control Needle. 2. Damaged Ball Valve. con. passage. 3. Damaged Ball Valve needle. 4. Incorrect assembly of ball valve needles. 5. Excessive friction between cable and casing.	(a) 1. Change reservoir assembly. 2. Change reservoir assembly. 3. Change reservoir assembly. 4. Change reservoir assembly. 5. Ease or fit new cables.
		(b) H.P.P.R. continues to sink.	(b) 1. Loosely adjusted B.C. Cable. 2. As for 2 (b) above.	(b) 1. Re-adjust control cable. 2. As for 2 (b) above.
4.	Gun continues to fire after pressure is removed from fire control lever.	Gear functions correctly otherwise.	1. Maladjustment, defective or bad fitting of control cable. 2. Defective B.C. Needle. 3. Defective Control Needle. 4. Tight generator cup packing.	1. Adjust and replace as necessary. 2. Return assembly to stores. 3. Return assembly to stores. 4. Operate gear frequently or replace packings.

NOTE.—*Fault No.* 3.—*Notification*: Read this assuming that operator has applied the normal pressure and believes that the fire control lever is right home.

Conversion of "Double" Reservoir for Single Gun Installation.

Reservoirs for single gun installation are issued with a (steel) H.P. plug inserted in one secondary pipe line port and a dust excluder in the other. This enables the most convenient connection of pipe lines and fire control cable in the aircraft to be used.

Important Note.

Ball valve needles are not standard in size and are individually lapped and fitted to each valve before issue. They are therefore not interchangeable and care must be taken that they are always assembled in their correct chambers as issued.

Fire Control Levers.

In aircraft fitted with single gun installation, the right hand lever is always to be used for firing the gun. The left hand lift is to be used for operating the "fixed" camera.

Care and Maintenance.

The efficiency of the gear depends entirely upon regular and efficient maintenance by the armourer.

The detailed maintenance to be carried out will probably vary with different types of aircraft and which will be published in Unit Aircraft Maintenance Order.

The following points of daily maintenance are given as a general guide:—

Before Firing:—

1. Check oil lever in reservoir.
2. Test and examine reservoir for defects and security.
3. Examine pipe lines for damage, leaks, etc.
4. Inspect fire control cable for fraying and test for correct operation.
5. Examine generator for security.
6. Inspect trigger motor for security.
7. Test air release valve for correct action.
8. Test for correct operation of gear with the engine running.

After Firing:—

Release tension on H.P.P.R. spring by opening air release valve, and operating fire control levers.

Changing from "Normal" to "Low Temperature" Conditions.

The changing of the mixture in the gear from that for normal conditions to that suitable for low temperature conditions will necessitate draining the gear.

This should be done by disconnecting the main pipe line unions at both the trigger motor and generator ends, disconnecting the secondary pipe lines at the reservoir and removing the reservoir from the aircraft. Empty the reservoir and re-instal.

Refill the gear and test at laid down.

Treatment of Leather Packings and Washers.

A quantity of each type of packing and washer should be kept ready for immediate use as replacement.

It will be found that a satisfactory method of preservation is by immersion in Neatsfoot oil. This is obtainable through Stores, Section 34B, Ref. N. 99.

Dust Excluders.

Dust excluders are supplied to fit all unions to prevent ingress of foreign matter into the system.

They are to be fitted whenever an assembly or component is removed from an aircraft for return to Store or held in the armoury as spare. In the event of these excluders not being available, the end and unions of pipes are to be covered with oiled rag when not installed in aircraft.

Nº 134

South African Air Force Standard Notes

ARMAMENT

Section G.

CHAPTER IV.

VICKERS GUN .303 in.

(Recoil)

Printed in the Union of South Africa by the Government Printer, Pretoria
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VICKERS GUN (RECOIL).

SYLLABUS.

Classroom Instruction.	*Lecture.*	*Page.*
(*a*) General Description, Names of Parts.	1 and 2	1 to 6
(*b*) Stripping and Assembling.....	3 and 4	6 to 9
(*c*) Practical Stripping and Assembling...	5 and 6	—
(*d*) Mechanism.....	7 and 8	9 to 15
(*e*) Mechanism by Pupils.....	9	—
(*f*) Stoppages and Immediate Action.....	9 and 10	15 to 18
(*g*) Stoppages and Immediate action by Pupils.....	11	—
(*h*) Operations, before between and after Flights.....	12	21 to 24
(*i*) Tests, Repairs and Adjustments and Gauges.....	13	24 to 29
(*j*) Cleaning and Storage.....	14	29 to 30
(*k*) Revision.....	15	—
(*l*) *Practical Instructions on Aircraft :—*		
Installations, Tests and Adjustments on Aircraft.....	16	—
Operations, before, between, and after Flight.....	Revision	Practical.
(*m*) *Range :*		
Belt Filling, Range Practice and Practical stoppages demonstration.		
Points before, during and after Firing and Practical Cleaning after Firing.		
Storage of the Gun.		

ARMAMENT.

SECTION G.

GUN VICKERS ·303 (RECOIL).

INSTRUCTIONAL EQUIPMENT.

(i) Guns Vickers ·303 (Recoil) complete.
(ii) Mounting machine gun Mk. IV.
(iii) Spring balance.
(iv) Tools combination.
(v) Rods cleaning flannelette and G.S. Oil.
(vi) Dummy rounds (10) and prideaux links.

VICKERS GUN TESTS.

1. Candidates should be able to pass the following tests satisfactorily :—

(*a*) Be able to strip and assemble the following parts quickly and easily :—

(i) The gun.

(ii) The lock.

(iii) The feed block.

(*b*) Be able to clear correctly any three stoppages set up by the examiner.

(*c*) Be able to perform the operations of loading and unloading the gun correctly.

2. The following faults will be grounds for failure in the tests enumerated at sub-paragraph (1) :—

(*a*) More than three mistakes in the sequence of stripping and assembling the gun or any part thereof.

(*b*) Inability to clear two of the three stoppages referred to in (1) (*b*) above.

(*c*) Rough, careless, or awkward handling of the gun or any part thereof.

GUN, VICKERS, ·303″, AIRCOOLED, MARK V.

General Description.

Name of gun	Gun, Vickers, ·303 inch, Aircraft Mk. V.
Weight	29 lb. (approximately).
Rate of fire	900 rounds per minute (approx.).
Bore of barrel	·303 inch.
Type of rifling	Enfield, left hand, with twist of 1 turn in 10 inches; 5 grooves.
Length of barrel	28·4 inches.
Length of gun	45¾ inches.
Working weight of fusee spring	10-12 lb.
Mark on gun	Registered number and mark of gun is engraved on the Trunnion Block between the Breech and Barrel Casings.

Control of Fire.

The gun is automatic in its action, i.e. will fire all the rounds in the belt if the trigger is prevented from engaging the tumbler, but it is not automatic when fired by means of the machine gun synchronising gear, as this apparatus ensures that the trigger is tripped only at definite required intervals.

Cooling System.

The gun is cooled by air flow over the barrel.

Heating System.

The gun may be fitted with electric heaters to prevent it from being jammed in conditions of extreme cold due to the oil used for lubrication becoming congealed.

Method of Issue.

Mark V guns are issued as Right Hand and Left Hand according to the requirements of aircraft and are not interchangeable. They can be identified by means of the marking " Mk V " stamped on the trunnion block.

Where components of earlier pattern guns are fitted to the Mk. V gun they are stamped " 3 ".

Names of Parts.

The gun is divided into the following parts:—

(*a*) Non-recoiling portions;
(*b*) Recoiling portions.

The *non-recoiling portions* consist of:—

1. *Muzzle Attachment Ball. Mark III.*

(*a*) Muzzle cylinder.
(*b*) Sleeve, plunger and spring.
(*c*) Flash eliminator.
(*d*) Tab washer.

2. *Barrel Casing.*

3. *Trunnion Block.*

(*a*) Front mounting bracket (*f*).

NOTE.—(*f*) Denotes feature of main component.

4. *Breech Casing.*

(*a*) Right outer side plate (*f*).
(*b*) Left outer side plate (*f*).
(*c*) Bottom plate (*f*).
(*d*) Rear mounting bracket (*f*).
(*e*) Right and left slides.
(*f*) Roller, collar and split pin.
(*g*) Check lever bracket (*f*) and check lever.
(*h*) Solid cams (*f*).
(*i*) Extractor safety stop bracket (*f*).
(*j*) Extractor safety top plunger.
(*k*) Extractor safety stop lock.
(*l*) Extractor safety stop spring.
(*m*) Extractor safety stop knurled cap.
(*n*) Front cover.
(*o*) Front cover hooks (*f*).
(*p*) Front cover axis pin.
(*q*) Front cover joint collar.
(*r*) Front cover catch, lever, plunger, cap and spring.
(*s*) Auxiliary extractor stop (*f*).
(*t*) Rear cover.
(*u*) Rear cover catch, spring, plunger and split pin.
(*v*) Ramps (*f*).

(*w*) Rear cross piece.
(*x*) Rear cross piece axis pin.
(*y*) " T "-Fixing pin.

5. *Feed Block.*

(i) *Right Hand:*—

(*a*) Levers split pin.
(*b*) Top lever.
(*c*) Bottom lever.
(*d*) Slide.
(*e*) Top pawls, top pawls extension and top pawls spring.
(*f*) Bottom pawls, bottom pawls spring and Axis pin.
(*g*) Cartridge stop.
(*h*) Bullet stop.
(*i*) Cartridge rim guide.
(*j*) Strips, cartridge guide.

(ii) *Left Hand:*—

The left hand feed block is similar to above but of reverse design, with the following exceptions:—

(*a*) Item (*f*) above should read:—
Retaining pawls; retaining pawl spring and screwed axis pins.
(*b*) Add item (*b*) (i) top lever cam.

6. *Fusee Spring Box.*

(*a*) Front and rear anchorages (*f*).

7. *Fusee Spring.*

(*a*) Fusee spring hooks (*f*).
(*b*) Fusee spring adjusting screw.
(*c*) Fusee spring adjusting screw vice pin (*f*).

8. *Fusee.*

(*a*) Fusee chain (*f*).
(*b*) Cross pin (*f*).
(*c*) Spindle (*f*).

Loading Mechanism:—

(*a*) Locking nuts.
(*b*) Operating handle.
(*c*) Loading lever.
(*d*) Distance piece.

(*e*) Return spring.
(*f*) Splined shaft.
(*g*) Operating handle stop.
(*h*) Loading mechanism bracket.
(*i*) Retaining spring.
(*j*) Return spring anchorage.

Recoiling Portions :—

1. *Barrel and Muzzle Cup.*
2. *Left Inner Side Plate.*
   (*a*) Prolongation (*f*).
   (*b*) Spring (*f*).
3. *Right Inner Side Plate.*
   (*a*) Spring.
4. *Crank.*
   (*a*) Connecting rod and adjusting nut.
   (*b*) Crank pin.
   (*c*) Crank journals, left and right (*f*).
   (*d*) Crank handle.
   (*e*) Connecting rod retaining spring (*f*).
5. *Lock.*
   (*a*) Side levers axis bush and split pin.
   (*b*) Side levers and head.
   (*c*) Extractor levers.
   (*d*) Extractor, gib and gib spring and gib spring cover.
   (*e*) Tumbler and axis pin.
   (*f*) Trigger and axis pin.
   (*g*) Firing pin.
   (*h*) Sear and sear spring.
   (*i*) Lock frame.
   (*j*) Extractor stop.

The left hand gun differs from the right hand gun in that the following parts are of reverse design :—

// 1. Loading mechanism bracket.
// 2. Loading mechanism loading lever.
// 3. Loading mechanism distance piece.
4. Loading mechanism operating lever return spring.
// 5. Crank and crank handle.
// 6. Fusee and chain; fusee spring box.
7. Check lever bracket and // check lever.
// 8. Extractor safety stop plunger.

9. Plates extension, cover joint, L. and R. M.K. III.
//10. Slide No. 3, Mk. I.

The // right inner plate has been modified to allow clearance for the hook of the fusee spring.

NOTE.—All parts marked " // " are stamped with the letters " L.H." for identification.

GUN, VICKERS, 303, MARK III.

Two patterns of Mk. III guns are issued :—

(*a*) *Mk. III. D.* (*Day*) :—
Weight ... ... 28 lb. 7 oz.
Length ... ... 40¾ inches.

(*b*) *Mk. III. N.* (*Night*) :—
Weight ... ... 29 lb.
Length ... ... 45¼ inches.

They differ only in the type of muzzle attachment fitted :—

Mk. III. D.—Muzzle Attachment, Ball, Mk. II.
Mk. III. N.—Muzzle Attachment, Ball, Mk. III.

The Mark III. gun is almost identical with the Mk. V. right hand gun, with the exception of the rear cover.

This gun is converted to left hand feed by changing the feed block.

Stripping and Assembling.

1. *To Strip the Gun :—*
   (*a*) See that the gun is unloaded.
   (*b*) Disconnect pipe lines and electric heaters if fitted.
   (*c*) Remove the lock.
   (*d*) Remove muzzle attachment.
   (*e*) Remove muzzle cup.
   (*f*) Remove buffer spring.
   (*g*) Remove feed block.
   (*h*) Remove fusee spring box and fusee spring.
   (*i*) Remove fusee and chain.
   (*j*) Remove " T "-fixing pin.
   (*k*) Remove rear cross piece axis pin.
   (*l*) Remove rear cross piece.
   (*m*) Remove right and left slides.

(*n*) Withdraw barrel and inner side plates.
(*o*) Separate barrel and inner side plates.

To assemble reverse the above order.

2. *To Strip the Lock:*—

The only tool required to strip the lock is the "T"-fixing pin.

(*a*) Ensure lock if *fully cocked.*
(*b*) Remove side levers axis bush split pin.
(*c*) Remove side levers axis bush.
(*d*) Remove side levers.
(*e*) Remove extractor levers.
(*f*) Remove extractor.
(*g*) Remove tumbler axis pin and tumbler.
(*h*) Depress tail of sear.
(*i*) Force out trigger axis pin.
(*j*) Remove trigger.
(*k*) Remove lock spring.
(*l*) Depress tail of sear and allow firing pin to slide out.
(*m*) Raise tail of sear and remove sear.

To assemble reverse the above procedure with the exceptions:—

(*a*) Replace tumbler before trigger.
(*b*) Replace lock spring when all other parts are assembled and in the fired position, i.e. "*All Tails Down*".

3. *To Strip the Extractor:*—

(*a*) Push out gib spring cover.
(*b*) Remove gib and spring.

To assemble reverse above, ensuring cover is fully home.

4. *To Strip the Feed Block (R.H.):*—

(*a*) Remove levers split pin.
(*b*) Separate top and bottom levers, using "T"-fixing pin if necessary.
(*c*) Remove slide.
(*d*) Remove bottom pawls axis pin.
(*e*) Remove bottom pawls and spring.

To assemble reverse above procedure.

5. *To Strip the Feed Block (L.H.):*—

(*a*) Remove levers split pin.
(*b*) Remove top lever cam from bottom lever.

(*c*) Remove top lever.
(*d*) Remove the slide.
(*e*) Unscrew and take out retaining pawls screwed axis pins.
(*f*) Remove retaining pawls and spring.

To re-assemble reverse above procedure.

6. *To strip the Loading Mechanism:*—

(*a*) Remove split pins and lock nuts from shaft.
(*b*) Withdraw operating handle.
(*c*) Withdraw loading lever.
(*d*) Withdraw distance piece, at same time disconnect return spring.
(*e*) Withdraw splined shaft.
(*f*) Remove operating handle stop.

To Assemble:—

(*a*) Place operating handle stop between lugs of bracket.
(*b*) Insert splined shaft, engaging operating handle stop, long spline to the right or left.
(*c*) Assemble loading lever, operating face just clear of knob of crank handle when latter is as far down as possible on the long splines.
(*d*) Assemble operating handle on long spline—boss facing inwards.
(*e*) Replace lock nut and split pin.
(*f*) Assemble return spring to distance piece and engage other end to stud on bracket.
(*g*) Push the distance piece on to the short end of the splined shaft, ensuring return spring is sufficiently tensioned to force the operating handle fully forward and engage operating handle stop with the retaining spring.
(*h*) Replace lock nut and split pin.

Mechanism.

Assuming that:—

1. The gun is fully loaded with live rounds which form part of a belt of cartridges.
2. The tail of trigger has been tripped.

Action of Recoil.—On the explosion of the charge the gases formed force the bullet along the barrel and follow in their efforts to escape. Meanwhile, by direct recoil action, the recoiling portions are forced to the rear, a

distance of approximately one inch (the movement of the lock and connecting rod owing to the rotary action of the crank is considerably greater), the fusee spring being thereby partially extended. This movement is further assisted by the action of the gases, which, striking against the muzzle cylinder, re-bound on to the muzzle cup, helping to force the recoiling portions to the rear.

After the recoiling portions have moved to the rear $\frac{3}{8}$ths of an inch, the holes in the muzzle cylinder are uncovered and allow the gases to escape.

First Action of Feed Block (Right Hand).—At the moment of the explosion the top pawls are holding a round in position against the cartridge and bullet stop and the bottom pawls are engaged behind the second round in the belt. As the recoiling portions move to the rear, the stud on the bottom lever being engaged with the recess in the prolongation of the left inner side plate, the bottom lever is rotated to the rear, and, acting on the top lever, moves the top lever from left to right.

The top lever moves the slide from left to right, and the top pawls, riding over the round already held by the bottom pawls, are forced down by the top pawls spring to engage behind that round.

Backward Rotation of the Crank.—As the recoiling portions move to the rear, the tail of the crank handle bears against the roller, causing an upward and backward rotation to be imparted to the crank and connecting rod, thus withdrawing the lock from the barrel and opening the breech. This movement causes the fusee chain to be wound around the fusee, thereby further extending the fusee spring.

When that portion of the crank handle beyond the depression bears on the roller, the recoiling portions start their forward movement, with the exception of the lock and connecting rod, which still continue to move to the rear a short distance, then join in the general forward movement.

This movement is assisted by the fusee spring.

Backward Movement of Lock.—When the explosion has taken place the extractor is gripping—

(i) A live round (in the feed block) between the upper and lower projections of the gib;

(ii) An empty case (in the chamber) beneath the lower projection of the gib.

As the lock moves to the rear, the live round and empty case are withdrawn and the horns of the extractor ride along the tops of the solid cams, depressing the extractor safety stop plunger. The plunger safety stop is forced inwards under the action of its spring when the horns of the extractor have passed.

The horns of the extractor are forced downward by the ramps on the rear cover, the extractor thus bringing the live round in line with the chamber. The empty case should fall off, but in the event of its retention on the extractor it will be forced off during the forward movement of the lock.

Cocking Action of the Lock.—As the recoiling portions move to the rear, the crank and connecting rod rotate and impart this rotation to the side levers. The tail of the tumbler is raised by the side levers head, causing the tumbler to rotate. The head of the tumbler being engaged in the recess of the firing pin, withdraws it from the firing pin hole.

This movement further compresses the lock spring, the short arm causing the nose of the trigger to bear against the tumbler, and as the tumbler rotates, the nose of the trigger rides over, but does not engage with, the bent of the tumbler.

On further rotation of the tumbler the lock spring is still further compressed and the firing pin further withdrawn. The sear is forced up by the sear spring and the bent on the sear engages with the bent of the firing pin, thus holding the firing pin fully to the rear.

The lock is now fully cocked.

Second Action of Feed Block.—As the recoiling portions move forward, the bottom lever is rotated forward and acting on the top lever causes the top lever to move from right to left. The top lever moves the slide from right to left and the top pawls force the first round in the belt against the cartridge and bullet stops.

This movement causes the belt to be drawn one round further into the feed block, the second round rides over and depresses the bottom pawls. The bottom pawls are forced up by their spring and engage behind the cartridge and retain the belt in the feed block when the first round is withdrawn.

Forward Rotation of the Crank.—The force of the explosion by this time being expended, the fusee spring takes control of the action of the gun. The fusee chain is unwound from the fusee and this movement imparts a forward and downward rotation to the crank and connecting rod which forces the lock forward.

Forward Movement of the Lock.—As the lock travels forward, the live round is forced into the chamber; the side levers act upon the extractor levers raising the extractor. The upper projection of the gib rides over the base of the cartridge positioned in the feed block, until the base of the round is held between upper and lower projections. The lower projection rides over the base of the cartridge in the chamber and the firing pinhole is brought into line with the firing pin and the cartridge in the chamber. The extractor is thus raised to its position against the extractor stop.

If the empty case has not already fallen off, it will be forced off by the seating for ejection as the extractor rises.

After the extractor reaches its highest position against the extractor stop, the lock travels slightly further forward until the breech is completely closed. During this movement the steps on the side levers engage with the bents on the extractor levers, thus holding the extractor steady. Whilst the breech is closing the side levers head bears down upon the tail of the sear and thus disengages the bent on the sear from the bent on the firing pin.

The firing pin is thus freed to be carried forward under the influence of the lock spring, until the nose of the trigger engages with the bent on the tumbler.

Firing Action on Opening or Resuming Fire.—The gun is fired by means of the Machine Gun Synchronising Gear and on operating this gear, the trigger motor push rod is forced out and bearing against the tail of the trigger rotates the trigger on its axis, disengaging the nose of the trigger from the bent on the tumbler. The firing pin is then carried fully forward under the influence of the lock spring, the nose of the firing pin striking the cape of the cartridge and igniting the charge.

When continuous fire is taking place, the trigger motor push rod is being forced out at regular intervals, and, as the lock nears the end of its forward movement, the tail of the trigger is tripped, thus preventing the engagement of the nose of the trigger with the bent on the tumbler. After the breech is closed the tail of the sear being depressed, the firing pin is carried forward on to the cap of the cartridge in the chamber.

Cessation of Fire.—When the operation of the Synchronising Gear is discontinued, the lock will complete its forward movement without the tail of the trigger being tripped. The sear is depressed and the firing pin will be held to the rear by means of the engagement of the nose of the trigger with the bent of the tumbler.

Safety Devices.

1. *The Timing of the Sear.*—A very short period of time elapses between the closing of the breech and the firing of the round due to the side levers head moving slightly below the horizontal before the bent of the sear is released from the bent on the firing pin. This ensures that the breech is positively closed before the round can be fired.

2. After the firing of the round, the complete recoiling portions move to the rear through a distance of 12-25 thousandths of an inch before the tail of the crank handle bears against the roller. This ensures that the bulk of the gases are allowed to escape before the breech is opened.

3. *The Check Lever* prevents the crank handle from rebounding, thus preventing a premature opening of the breech.

4. *The Extractor Safety Stop* ensures that, in the event of a short recoil, which permits the completion of the feed block actions, the lock cannot travel forward with the extractor in the raised position. This prevents the live round on the extractor from striking the cap of the live round in the feed block and causing an explosion in the feed block.

Mechanical Action of Loading.—Place the single end of a correctly filled belt in the feed block, ensuring that the first round in the belt is held by the bottom pawls.

On operating the operating handle fully to the rear for the first time, the loading lever, bearing against the knob of the crank handle, causes the backward rotation of the crank and the withdrawal of the lock from the barrel.

The loading lever bearing on the boss of the crank handle forces the recoiling portions to the rear actuating the first operation of the feed block, the top pawls engaging behind the first round in the belt. The fusee spring is fully extended.

On releasing the operating handle, the recoiling portions move forward, the second operation of the feed block takes place, and the first cartridge in the belt is placed against the cartridge and bullet stops.

The lock moves forward and the extractor rises, gripping the base of the cartridge in the feed block. This forward movement is actuated by the fusee spring.

On repeating the movement of the operating handle a second time, the cartridge is withdrawn from the feed block, brought into line with the chamber and another cartridge brought to bear against the cartridge and bullet stops. The recoiling portions go forward, the cartridge on the extractor is placed in the chamber and the extractor grips the cartridge in the feed block.

The gun is now fully loaded.

Mechanical Action of Unloading.—Assuming cessation of fire, the extractor is holding one cartridge in the feed block and another in the chamber.

On pulling back the crank handle, the lock withdraws both cartridges and as the extractor is forced down, the bottom cartridge should fall off.

During this operation there is no movement on the part of the inner side plates, barrel, etc., so no feed block action takes place. The fusee spring is partially extended.

On releasing the crank handle, the lock is forced forward placing the cartridge from the feed block into the chamber. When the breech is fully closed the extractor is holding only one cartridge, i.e. in the chamber.

On repeating the operation of the crank handle, the cartridge withdrawn from the chamber is ejected, and when the breech closes there are no cartridges on the extractor. The gun is now unloaded, i.e. "*Clear Gun*".

The horns of the extractor should now be engaged in the steps of the solid cams, i.e. "Lock Hung".

Stoppages.

Definition of Immediate Action.—The immediate application of a probable remedy for a stoppage, based on the position of the crank handle. Immediate action is not to be considered to be complete until the gun has been fired and has functioned satisfactorily. The four recognised positions of the crank handle for stoppages are:—

No. 1 *Position:* Crank handle right back.

No. 2 *Position:* Top of crank handle approximately level with rear cover.

No. 3 *Position:* Crank handle about ½ inch from check lever.

No. 4 *Position:* Crank handle right forward, i.e. in the firing position of the gun.

Table of Immediate Action.

Position of Crank Handle.	Immediate Action.	Result of I.A.	Cause.	Remedy.
First Position : Crank handle right back.	Pull back crank handle on to roller. Let go. Fire.	(*a*) Gun Fires	(*a*) 1. Deteriorated ammunition. 2. Tight Packing in links.	Annual Inspection by A.I.D Inspector. Compliance with "Points before firing". Use Electric heater and fire occasional short bursts.
		(*b*) Gun fires but repeats stoppage	(*b*) Excessive friction due to congealed oil	
Second Position : Top of crank handle level with rear cover*	Raise rear cover, draw back crank handle. (Engage retaining catch). Clear Face of extractor with butt end of clearing plug. Close rear cover and release crank handle (from retaining catch), half-load. Fire.	1. Gun Fires	1. Separated case due to insufficient support of lock on base of cartridge. Front portion of the separated case being telescoped and withdrawn on the next round.	1. Correct gauging of the length of the connecting rod.
		2. Gun repeats stoppage.	2. Separated portion of case in chamber	2. Use clearing plug to remove separated case. Half-load. Fire.
Third Position : Crank handle about ½" from check lever.	Strike down crank handle.	(*a*) Gun Fires	1. Excessive friction due to congealed oil 2. Friction of face of lock obstructing upward movement of extractor.	Use electric heaters and fire short bursts occasionally. High Standard of armourers training.

* Only necessary when clearing stoppages by the single-handed method.

Table of Immediate Action—(*Continued*).

Position of Crank Handle.	Immediate Action.	Result of I.A.	Cause.	Remedy.
Third Position :		(*b*) Gun fires but repeats stoppage.	1. As for (*a*) 1. 2. As for (*a*) 2.	1. As for (*a*) 1. Compliance with Points before firing. Change the lock.
		(*c*) Gun does not fire.	1. Slight cross feed. 2. Slightly misshapen link.	Force down extractor, raise crank handle *(engage retaining catch), push belt into correct position in feed block. *(Disengage retaining catch), strike down crank handle. Fire.
Fourth Position : Crank handle right forward i.e. in firing position of gun	Half-load-Fire.	(*a*) Gun fires.	Mis-fire ; defective ammunition.	NIL.
		(*b*) Gun does not fire.	1. Broken or damaged firing pin. 2. Broken Lock spring.	Unload, change lock, re-load.

* Necessary when clearing stoppages by the single-handed method.

The following would cause prolonged stoppages:—

(i) Loose or broken muzzle attachment or muzzle cup.

(ii) Broken gib or gib spring.

(iii) Broken fusee or fusee spring.

The following causes may bring about a " runaway " gun, i.e. the gun would fire automatically, irrespective of operation of the synchronising gear; the firing of the gun is therefore unsynchronised to the movements of the airscrew:—

(i) Broken nose of trigger.

(ii) Broken bent of tumbler.

(iii) Broken short arm of lock spring (broken immediately above axis of trigger).

(iv) Trigger motor push rod jammed in its " *out* " position.

To stop the gun from firing ease down on the operating handle and so prevent the lock from going home, raise rear cover, " hang " the lock and clear the face of the extractor.

Uses of the Tools, Clearing, Third Position, Mark III.:—

(i) To force the extractor to its lowest position.

(ii) To clear the face of the extractor.

(iii) To remove a round from the feed block.

Electric Heaters.

Use.—To counteract the effect of low atmospheric temperature on the lubricant, preventing it from congealing and impeding the correct functioning of the gun, by transmitting warmth to the inside of the breech casing.

Description.—Each heating set comprises two heaters. The heaters are identically the same, each heater consisting of a nichrome element wound spirally around three strips of mica and enclosed between strips of mica, the whole being contained in a sheet copper case. The two ends of the nichrome ribbon are connected to two terminal screws called binding posts. The binding posts pass through insulating bushes fitted in the breech casing to the outside of the gun and serve when secured by nuts as the means of attaching one end of the heater to the gun and also enable the electric cables to be attached.

An insulated cap is provided to protect the ends of the binding posts. The opposite end of each heater is secured to the gun by a copper rivet. Two twin flexible electric cables of sufficient length to reach the rear end of the gun run from the heaters to a two-pin plug socket. This plug, when the heaters are required, is plugged into the 12V supply of the aircraft. The consumption of each heater is two 1/12th amps.

Blank Firing Attachment: Mk. II.

The Marks III. and V. Guns can be adapted to fire blank ammunition by removing certain service components and fitting the following. Earlier pattern guns require the Mk. I. blank firing attachment:—

Barrel, Mk. II., D.P.B.
Muzzle Cup, B.F.M.A.
Casing, B.F.M.A.
Cone, B.F.M.A.
Adjusting Screw, B.F.M.A.
Adjusting Nut, B.F.M.A.

Tool Used.—Spanner, B.F.M.A.

Gauge Used.—·167 inch Plug Gauge.

Fitting.—The buffer spring is removed when fitting up the gun for blank firing. The barrel is specially choked immediately in advance of the chamber with a steel bush, having a vent hole through it of approximately ·16 inch diameter. This barrel is stamped D.P.B. on the trunnion block. The adjusting screw is assembled to the front cone from the rear end, the large end of the screw fitting into the muzzle cup, the outer end of the adjusting screw being secured after adjustment by the adjusting nut. B.F.M.A. cones are issued secured to the B.F.M.A. casings and permanently locked by a grub screw. The life of the D.P.B. barrel is dependent upon the size of the hole through the vent. This hole becomes enlarged by the action of the gases. The bush must reject the ·167 inch gauge.

The normal life of a barrel is 1,500 rounds.

Adjustment.—Weight of the recoiling portions not to exceed 2 lb. weight of the fusee spring not to exceed 4½ lb. With the gun assembled, screw in the adjusting screw from the front (having slackened the adjusting nut) until it comes against the muzzle cup and com-

mences to force the recoiling portions to the rear, then unscrew the adjusting screw two and a half turns and secure it with the adjusting nut. Should the gun fail to function with this adjustment, the adjusting screw may be screwed in by quarter turns, but it must never be less than one complete turn back from the muzzle cup. When loading belts with blank ammunition, care must be taken to see that the links do not grip the cartridges too tightly; on the other hand, very loose links must not be used.

Blank Ammunition Feed Block Guide.—This consists of a body, clamp block, screw and spring. Its purpose is to improve the feeding of blank ammunition through the feed block and eliminate cross feeds. The guide can be used in right or left hand feed blocks.

Locks, Breech, Mk. I. //.—The Mk. I. // Lock, fitted with a Mk. No. 3 Extractor, is being issued for use in Mk. V. Guns. The Mk. I. // differs from the Mk. I. in that the horns of the extractor are made thicker at the rear.

The purpose of the modified extractor is to eliminate possible No. 3 stoppages.

To enable the Mk. I // Lock to be used, Mk. V. guns are modified by removing metal from the front curvature of the solid cams. This modification is not to be carried out by units. Guns, when modified, are marked with a " + " on the right outside surface of the trunnion block.

Mechanism, Manual Firing.

For the Remote Control of Unsynchronised Vickers Guns.—The mechanism is operated by bowden cable. It is a standard Vickers gun trigger motor adapted for this purpose by removing the " T "-piece; Plunger; " U " Packing and " U " Packing Ring and fitting it up with the following parts:—

Guide Bracket,
Lever,
Control Plunger,
Buffer Spring Box,
Buffer Spring,
Plunger.

Operation.—The operation of the bowden cable pulls the lever, causing the control plunger to push the buffer

spring box and plunger against the trigger motor push rod, forcing it out against the tail of the trigger and compressing the trigger motor spring. So long as the trigger motor push rod is kept in this " OUT " position, the gun will fire automatically. The buffer spring damps out the shock caused by the trigger tail striking the trigger motor push rod in the forward movement of the lock. On release of the bowden cable, the trigger motor spring, by retracting the trigger motor push rod, to its " IN " position and re-positioning the other moving parts, causes the gun to cease fire.

NOTE.—These mechanisms are issued as complete units. They are fitted and adjusted in the same manner as the standard trigger motor.

Operations Before, Between and After Flight : (A.P. 1641A, Vol. II, Chapter 2).

GROUP " A ".

Operations Before Flight when Firing is to Take Place :

1. Inspect gun, attachments and mounting for security.
2. Clean and dry barrel, muzzle attachment, muzzle cup, buffer spring and face of extractor.
3. Clean and lightly oil all recoiling portions and working surfaces.
4. Check functioning of gun.
5. Check ammunition chutes, etc., for correct alignment and security.
6. Ensure correct engagement of belt in feed block.
7. Ensure tools and spare parts are correctly secured in aircraft.
8. Test gun heaters, if fitted.

GROUP " B ".

Operations Between Flights when Firing is Taking Place :

1. Ensure the gun is unloaded.
2. Remove any live or misfired rounds from aircraft.

GROUP " B ".

3. Obtain pilot's report and exchange parts as necessary.
4. Clean and dry barrel and gas affected parts.
5. Check correct functioning of gun after assembly.
6. Check security of gun, attachments and mounting.
7. Check security and alignment of ammunition chutes, etc., and insert new link belt.
8. Enter up gun history sheet.

GROUP " C ".

Operations After Flight when Firing has Taken Place:

1. Ensure the gun is unloaded.
2. Remove any live or misfired rounds from aircraft.
3. Obtain pilot's report and exchange parts as necessary.
4. Remove gun from aircraft and take to armoury for cleaning.
5. Strip the gun and clean as follows:—

(*a*) *Barrel*	Boil and dry—remove fouling. Wipe exterior with oily rag.
(*b*) *Muzzle Attachment* *Buffer Spring* ... *Muzzle Cup*	Boil and dry—remove fouling.
(*c*) *Lock*	Boil and dry—remove fouling.
(*d*) *Inner Side Plates*	Boil and dry—remove fouling.
(*e*) *Breech and Barrel Casings*	Clean, dry and lightly oil.

(*f*) All components which have not been affected by gas are to be cleaned with an oily rag—dried and re-oiled lightly.

6. Examine the parts as follows:—

(*a*) *Muzzle Attachment.*—Freedom from fouling, fit and security of locking. Security of flash eliminator.

(*b*) *Muzzle Cup.*—For fractures. Fouling and damage to threads.

(*c*) *Buffer Spring.*—For fouling and correct height. (·78 H—·72 L.)

(*d*) *Barrel and Breech Casings.*—For distortion, fractures and wear.

(*e*) *Barrel.*—For fouling and chemical corrosion; damage to muzzle threads. Gauge for fouling wear, etc.

(*f*) *Feed Block.*—For correct " set " of top pawls. Wear on pawls. Security and condition of levers.

(*g*) *Left and Right Inner Side Plates.*—For distortion, burrs and fracture. Security and condition of spring.

(*h*) *Crank Assembly.*—Burrs, freedom of movement; condition of locking projections on connecting rod; security of adjusting nut.

(*i*) *Lock.*—Burrs, fractures and fouling on face of extractor. Protusion and radius of firing pin. Test gib spring.

(*j*) *Fusee, Spring and Cover.*—Hooks for damage; spring for tension. Adjusting screw and vice pin for condition. Fusee chain for distortion.

(*k*) *Right and Left Slides.*—Split pin-collar and roller for security. Rear fusee spring box anchorage for security.

(*l*) *Front and Rear Covers.*—For correct closing and engagement of catches. Play on hinges and joint.

(*m*) *Extractor Safety Stop.*—Ease of functioning; tension of spring. Wear on plunger.

(*n*) *Loading Mechanism.*—Fracture or damage to retaining spring. Presence of hide inset in L.M.O.H. stop. Serviceability of split pins.

7. Enter up gun history sheet.

Operation After Firing *2,000+500 Rounds:*

See A.P. 1641 A, Vol. II., Chapter 2, Group " F ".

Tests, Repairs and Adjustments.

(*a*) *Weighing and Adjusting the Fusee Spring:*—

1. Remove lock.
2. Place loop of spring balance over knob of crank handle.

3. Stand on left of gun and press check lever forward with left thumb.
4. Rest the right wrist on top of the breech casing and pull vertically upwards on spring balance.
5. Take reading when crank handle commences to move.
6. The weight should be 10-12 lb. for Aircraft Vickers and 7-9 lb. for Ground Vickers.

NOTE.—Vice pin of adjusting screw of fusee spring turned clockwise decreases weight and vice versa. (Six clicks or three revs. = approximately 1 lb.)

(*b*) *Weighing Recoiling Portions* :—

1. Remove buffer and fusee springs.
2. Place crank handle nearly vertical.
3. See the gun is in a horizontal position.
4. Place loop of spring balance over boss of crank handle, and pull slowly to the rear.
5. The weight recorded when the recoiling portions commence to move should not exceed 2 lb. for an Aircraft Vickers or 4 lb. for Ground Vickers.

(*c*) *Testing Length of Connecting Rod* :—

1. Remove fusee spring.
2. Remove sear from lock.
3. Remove extractor safety stop in Mk. III. and V. Guns.
4. Replace lock and place crank handle on to roller.
5. Insert ·064 inch gauge on to face of extractor and opposite firing pin hole from the underside of breech casing.
6. Lift the extractor to its highest position by pushing upwards on the gauge; see the barrel is home and take crank handle forward, slowly guiding the gauge into the chamber.
7. Push head of check lever out of path of crank handle.
8. If connecting rod is correct length, a slight check will be left just before crank handle

reaches check lever. If no check is felt, the lock is not fully home, i.e. connecting rod is short.

(*d*) *Adjusting Length of Connecting Rod* :—

1. Remove lock and place a No. 1 adjusting washer on the outer face of the connecting rod adjusting nut. Replace lock.
2. Re-test, adding Nos. 1 and 2 washers as required until connecting rod is correct length.
3. Remove lock and washers, Remove adjusting nut with the aid of combination tool. Place washers on connecting rod and screw adjusting nut tightly home.
4. Replace lock and re-test.

NOTE.—No. 1 washer has one hole in its rim and is 3/1000 inch thickness.

No. 2 washer has two holes and is 5/1000 inch thick.

(*e*) *Weighing Lock Spring.*

1. Fully cock the lock.
2. Place bottom of lock on flat surface.
3. Place loop of spring balance over side lever head.
4. Pull upwards at right angles to side lever head, when weight required to move the tumbler should be from 11 to 14 lb.

(*f*) *Testing Lock* :—

(i) *Side and Extractor Levers* :

1. Remove feed block and keep front cover raised.
2. Draw back crank handle, then take it forward slowly until home.
3. If correct, the extractor should have no vertical play when the lock is home.

(ii) *Bents of Sear and Firing Pin* :

1. Pull crank handle on to roller.
2. Trip tail of trigger as lock goes forward.
3. There should be no upward jump of extractor as the firing pin flies forward when released from the sear.

(iii) *Extractor:*

1. Remove lock.
2. Examine face of extractor for burrs or flaws.
3. Pass the ·064 inch gauge through the grooves.
4. Test gib and its spring with ·058 inch gauge.

(iv) *Nose of Trigger and Bent of Tumbler:*

1. Fully cock the lock.
2. Release the sear from firing pin when lock should cock on trigger and tumbler.

(v) *Firing Pin:*

1. Place the lock in the fired position.
2. Hold the lock with extractor face downwards, and withdraw the firing pin by operating side lever head.
3. If point is withdrawn, firing pin is not broken.
4. Test protrusion and radius of point; ·056 inch—·068 inch; radius ·038 inch.

(g) *Repairs to the Lock:—*

When it is necessary to replace any component part of the lock (e.g. firing pin) several of these components should be tried and the best fit chosen.

Lock springs will be changed every 2,000 rounds.

Gauges used with the Vickers ·303″ Gun.

Cartridge Head, ·064 *inch, No.* 1:—

To assist in testing the correct closing of the breech. Used when the lock is exchanged or when adjusting the length of the connecting rod.

Cartridge Head, ·058 *inch:—*

To test the serviceability of gib and gib spring. It should be held firmly by the gib and not droop.

Diameter of Barrel at Muzzle Bearing, ·627 *inch:—*

This is applied not less than 1½ inches and not more than 3 inches from the muzzle. If the gauge is accepted, the barrel is to be exchanged.

Plug, ·301 *inch:—*

Used to detect the presence of metallic fouling in the barrel.

Plug, ·307 *inch:—*

Used after the ·301 inch; if this gauge passes through the barrel, it indicates the limit of wear allowed has been reached and the barrel should be exchanged.

Plug, ·308 *inch, No.* 2:—

Used to detect wear at the muzzle end of the barrel. If this gauge is accepted more than a quarter of an inch at the muzzle, the barrel should be exchanged.

Plug, ·310 *inch:—*

Used to detect wear of the rifling immediately in advance of the lead. If the rear end of gauge comes level with or descends below the breech face of the barrel the barrel should be exchanged.

Lead No. 2:—

Used to detect wear in the lead. If the rear end of the gauge comes level with or descends below the breech face of the barrel, the barrel should be exchanged.

Plug, Rod (2 *per cent.*):—

For use with the ·307 inch and ·301 inch gauges.

Plug, Handle:—

For use with the ·310 inch and lead gauges.

Height and Radius of Firing Pin Point, ·056 *inch and* ·068 *inch:—*

With the lock in the fired position, it is used to test the correct protrusion and radius of the point. The point must rock on the ·056 inch and clear the ·068 inch gap.

Length of Buffer Spring, ·72 *inch:—*

Used to detect shortening of the spring, the spring should be applied edgeways to the gap in the gauge, if accepted, the spring is too short and should be exchanged.

Plug, ·167 *inch for D.P. Barrel:—*

Used to detect wear in the vent of the choke bush. If the gauge is accepted, the barrel should be exchanged.

Plug, Long, ·303 inch, Special:—

Used to detect any droop of the muzzle attachment as revealed by lack of concentricity of the hole in the front cone when the gauge is inserted in the barrel.

Tools and Spare Parts to be taken in the Air.

Tools, clearing 3rd Position Stoppages, Mk. III. Spare Lock.

Care in Handling:—

1. Handle carefully to avoid damage.
2. Do not operate crank handle unless lock is in the gun.
3. Lock springs should be " eased " and not left compressed for unnecessarily long periods.
4. Unless a cleaning rod of suitable length is available, the lock is to be removed from the gun whenever the barrel is to cleaned.

Cleaning and Storage:—

1. *Preliminary Cleaning.*—As for " Operations between Flights when Firing has taken Place ".
2. *Principal Cleaning.*—As for " Operations after Flight when Firing has taken Place ".
3. *Subsequent Cleaning.*—Where guns have been fired and cleaned and are not to be used again immediately, but stored in the Armoury, the barrels and gas affected parts are to be cleaned and oiled daily for a period of 10 consecutive days. Failure to do this will inevitably result in these parts becoming rusty through " sweating ".
4. Guns that are stored in the Armoury, and which may be required for use at short notice are to be stripped and cleaned each week, re-assembled and left lightly oiled with Oil, Anti-Freezing, Type " A ". They are to be stored, with tension of fusee spring eased, covered up in racks, or in gun chests, in the horizontal position.

5. Guns that are kept in the Armoury, which are not required for use at short notice, are to be kept in their chests and are treated as follows:—
   (*a*) All unpainted steel surfaces are to be coated with a thin layer of mineral jelly.
   (*b*) Barrels are to be filled with a mixture of 95 per cent. mineral jelly and 5 per cent. beeswax, applied in fluid state by heating.
   (*c*) Locks are to be dipped in mineral jelly (hot) and stored separately from the gun under lock and key.
   (*d*) Fusee springs must have tension removed.

These guns must be stripped, cleaned, examined and re-greased once every six months, a note to this effect being made on the label attached to the gun.

Gun, Vickers, ·303", Watercooled, Mk. I.

General Details:—

Weight:	
Empty	36 lb. (approx.)
Full	48¾ lb. (approx.)
Rate of fire	500 rounds per minute.
Overall length	43½ inches.
Working weight of fusee spring	7 to 9 lb.
Marks on the gun	Registered No. of gun engraved on top rear of barrel casing.

Sights:—

(*a*) Tangent " U " rear sight; sighted to 2,900 yards.
(*b*) " Battle " aperture rear sight; sighted to 400 yards.
(*c*) Blade foresight used in conjunction with (*a*) and (*b*).

Cooling System.—The barrel is cooled by being in contact with water.

Major Differences from Vickers, Aircraft.

1. Barrel casing fitted with steam tube.
2. Barrel packed at cannelure and gland.
3. Muzzle attachment.
4. No buffer spring.
5. Breech casing.
6. A sliding shutter on the underside of breech case.
7. Fire control mechanism.
8. Blades and aperture sights.
9. Rear cross-piece.
10. No loading mechanism.

Nomenclature of Principal Parts Special to Ground Gun

Steam Tube :—

Sliding valve.
Keeper screw.

Muzzle Attachment :—

Gland.
Casing.
Muzzle cone.
Muzzle disc.
Muzzle attachment chain and split pin.

Fire Control Mechanism :—

Trigger bar and spring (fitted in rear cover) ... ...
Firing lever ... ...
Firing lever pawl ... ...
Trigger bar lever ... ...
Safety catch ... ...
Safety catch spring and plunger ...
Firing lever axis pin ... ...
Safety catch axis pin ... ...

} Fitted to rear crosspiece.

Tangent Backsight :—

Stem with rack.
Tangent sight piston spring and axis pin.
Gradudated plate with screw, upper and lower.
Slide with nut, washer and split pin.

Sliding Shutter.—The sliding shutter must be OPENED before the gun can be loaded.

Mechanism.

Firing Action on Opening or Resuming Fire.—On raising the safety catch and pressing the thumb-piece of the firing lever, the pawl of the firing level presses the tail of the trigger bar lever forward, causing this lever to rotate on the " T " fixing pin. As the trigger bar lever rotates, its head, engaging a projection on the rear end of the trigger bar, withdraws the trigger bar to the rear, compressing the trigger bar spring. The front end of the slot in the trigger bar, pulling against the tail of the trigger, disengages its nose from the bent of the tumbler, releasing the lock spring, which, forcing forward the firing pin, fires the cartridge.

Continuous Fire.—If pressure is maintained upon the firing lever, the tail of the trigger is tripped by the trigger bar and prevented from engaging the bent of the tumbler as the lock goes forward. As a result, the gun fires as soon as the breech is closed by the side levers head, disengaging the bent of the sear from the bent of the firing pin.

Cessation of Fire.—On releasing pressure on the firing lever, the safety catch, firing lever and trigger bar level are returned to their normal positions by the compressed safety catch spring. This allows the trigger bar spring to force the trigger bar to its forward position, with the end of the slot of the trigger bar out of contact with the tail of the trigger. As the lock now moves forward, the trigger is allowed to engage the tumbler when the sear is released from the firing pin and the gun ceases fire.

Safety Devices.

Safety Catch.—If the safety catch is not raised, insufficient movement is allowed the firing lever to enable it to operate the trigger bar lever and withdraw the trigger bar into contact with the trigger of the lock.

Testing, Repairs and Adjustments.

These operations are as for the Mk. V. Gun with the following addition :—

Removal of Asbestos Packing :

1. Strip the gun, and pack the barrel cannelure with asbestos string, pressing the coils firmly into position,

ensuring no proudness of asbestos at edges of cannelure. Lightly oil the asbestos string.

2. Replace barrel and assemble the gun, with the exception of gland, muzzle cup and muzzle attachment.

3. Oil about 20 inch of asbestos string, wind loosely around the muzzle end of the barrel and push each coil into its seating with the point of a small drift.

4. Screw up the gland as far as possible by hand.

5. Remove the fusee spring and box, etc., and with the crank handle in the vertical position work the recoiling portions to and fro until a free movement is obtained. Gradually screw up gland, using the tools, combination, repeating the backward and forward movement to obtain freedom, until gland is fully home.

6. Weigh the recoiling portions, they should be approximately 4 lb.

7. Assemble gun.

NOTE.—(*a*) A weight slightly in excess of 4 lb. is permissible with new packing; this will decrease as the packing gets " run in ".

(*b*) Gland *must* be screwed fully home.

Tools for use with ·303″ Gun, Vickers.

Spanner, Muzzle Cup....	Removing Muzzle Cup.
Tools, Combination.....	Removing Muzzle Cone and Gland, Mk. I. Removing and replacing connecting rod. Adjusting nut.
Screwdrivers, Armourers, Large.	Removing and replacing various screws.
Screwdrivers, Armourers, Small.	
Pliers, Flat Nose.....	Removal of split pins.
Spanner, D/E., $\frac{1}{2}$″ x $\frac{7}{16}$″.	Removal, etc. of Loading Mechanism Bracket.
Rubber Hammer.....	Tapping out Loading Mechanism Splined Shaft, etc.
4-oz. Hammer.....	Separating top and bottom levers, etc.
Tools, Clearing, 3rd Position	Clearing 3rd position stoppages.
Plugs, clearing.....	Removing separated cases.
Balances, Spring, Mk. II	Weighing of springs, etc.
Tools, Removing Fouling, Muzzle Attachment	Removing carbon fouling.

South African Air Force Standard Notes

ARMAMENT

SECTION "G"

CHAPTER V

GUN, VICKERS ·303-in.

GAS OPERATED

Printed in the Union of South Africa by the Government Printer, Pretoria.
1939.

G.P.-S.11845—1939—1,000.

ARMAMENT SECTION "C".

CHAPTER V.

GUN, VICKERS ·303″ GAS OPERATED.

INSTRUCTIONAL EQUIPMENT.

(*a*) Guns, Vickers G.O. complete.
(*b*) Magazine 60 rounds.
(*c*) Rods cleaning, flannelette and G.S. Oil.
(*d*) Dummy Rounds.

ARMAMENT SECTION "C".

CHAPTER V.

GUN, VICKERS ·303″ GAS OPERATED.

SYLLABUS.

16 Lectures ($\frac{3}{4}$-hour each.)

	Lecture.	*Page.*
1. Classroom Instruction.		
(*a*) General description, names of parts	1 & 2	1 to 4
(*b*) Stripping Assembling	3 & 4	5 to 8
(*c*) Practical stripping and assembling by pupils	5 & 6	—
(*d*) Loading and Unloading the Gun and Magazine	7	8 to 9
(*e*) Mechanism	8 & 9	9 to 13
(*f*) Operations, before, between and after Flights. Group A, B, and C and Tests	10 & 11	14 to 17
(*g*) Cleaning and Storage	12	18 to 19
2. Practical Instruction.		
Magazine Filling	13	
Range Practices (Lewis Gun Table) A.P. 1244	14	
Points before, during and after firing and storage of the gun	15	
Revision	16	

VICKERS ·303" GAS OPERATED GUN, Mk. I, AIR SERVICE.

General Description.

Weight of gun, complete with sights, and deflector and bag	20½ lbs.
Overall length of gun, with flash eliminator	40 inches.
Length of barrel	20 inches.
Rifling	Left Hand.
Number of grooves	5.
Bore	·303 inches.
Rate of Fire (approx.)	950 r.p.m.
Capacity of magazines	60 and 100 rds.
Weight of magazines (empty)	60 rds. Capacity : 4 lbs. 100 rds. Capacity : 5½ lbs.
Weight of magazines (full)	60 rds. Capacity : 7½ lbs. 100 rds. Capacity : 11 lbs. (approx.)
Sights	Norman Vane and Enemy Speed Ring Sight.

Description of Parts.

The parts of the gun may be divided into two parts :—

(*a*) The stationary portions.

(*b*) The moving portions.

The main groups falling under these headings are sub-divided as follows :—

(*a*) *Stationary Portions :*

1. Barrel group.
2. Body and gas cylinder.
3. Return springs and return spring rod.
4. Spade grip and body extension.
5. Deflector and bag.
6. Magazine.

(*b*) *Moving Portions :*

1. The piston rod.
2. The breech block.

The names of the various parts composing each group are as follows :—

(*a*) *Barrel Group :*

1. Barrel.
2. Flash eliminator.
3. Foresight bracket.
4. Gas block with spigot.
5. Gas plug with port.
6. Rear sight bracket.
7. Magazine catch (front) and spring.
8. Locking lands.
9. Cartridge rim stops.

(*b*) *Body and Gas Cylinder :*

1. Body.
2. Piston stops, top and bottom.
3. Gas cylinder.
4. Magazine catch (rear).
5. Magazine catch (rear) flap and spring.
6. Locking shoulder.
7. Ejector.
8. Ejector cover.
9. Barrel strap with locking grooves.
10. Barrel strap bolt and nut.
11. Deflector catch brackets.
12. Body extension securing pins.
13. Retaining plungers and spring.
14. Cocking handle slide.
15. Cocking handle.
16. Cocking handle slide catch and spring.
17. Cocking handle lug and lug pin.
18. Return springs (2).
19. Return spring rod.

(*c*) *Body Extension:*

1. Body extension.
2. Spade grip with bolts.
3. Slide-pieces with screws and nuts.
4. Safety catch thumbpiece.
5. Safety catch, spring and plunger.
6. Buffer.
7. Buffer spring and cap.
8. Trigger
9. Trigger axis pin.
10. Trigger connecting rod, with lug and spring.
11. Trigger connecting rod spring guide and housing.
12. Sear.
13. Sear spring.
14. Sear axis pin.
15. Sear catch.
16. Sear catch spring.
17. Sear catch axis pin.
18. Sear buffer.
19. Sear lever.
20. Sear lever axis pin.
21. Sear buffer spring.
22. Sear buffer spring sleeve and plug.

(*d*) *Breech Block:*

1. Breech block.
2. Firing pin.
3. Firing pin spring.
4. Firing pin screw.
5. Feed piece.
6. Feed-piece axis pin, spring and plunger.
7. Extractor.
8. Extractor spring.
9. Locking shoulder.
10. Ejector cam groove.
11. Ejector slot.

(*e*) *Piston:*

1. Piston.
2. Piston bent.
3. Piston projection.
4. Breech locking cams.
5. Return spring housing.
6. Cocking handle lug slot.
7. Shoulders.
8. Piston bearings.
9. Piston head and rings.

(*f*) *Deflector and Bag:*

1. Frame.
2. Catch and spring.
3. Baffle plate.
4. Hinge brackets and pin.
5. Deflector bag and catch.
6. Deflector bag stiffener.

(*g*) *Magazine:*

1. Body.
2. Catch piece, rear.
3. Catch piece, front.
4. Spacer plate retaining springs (2).
5. Lips.
6. Bullet lead and feed piece cam.
7. Centre post.
8. Centre runway.
9. Outer runway.
10. Cartridge head guide.
11. Cartridge guide.
12. Dummy round stop.
13. Dummy round.
14. Dummy round spring.
15. Spacer plate.
16. Spacer (35).
17. Driving spring.
18. Spring housing.

19. Spring anchorage.
20. Driver and handle.
21. Driver hub and spring catch.
22. Driver lever.
23. Retaining pin.

Stripping and Assembling.

Stripping for Cleaning.—When the gun is to be stripped for cleaning, only the authorised tools are to be used and the following procedure adhered to:—

(i) *To Remove Body Extension, Return Spring, Breech Block and Piston Rod:*

(*a*) Ensure that the gun is unloaded and that the breech block is in the forward position.

(*b*) Remove the sights.

(*c*) Press and pull out body extension securing pins to their limit and withdraw the body extension.

(*d*) Remove the ~~sights~~. return springs rod.

(*e*) Pull back cocking handle sharply and withdraw the breech block and piston rod from the body.

(*f*) Replace cocking handle in its forward position.

(ii) *To Strip the Barrel Group:*

(*a*) Remove the split pin securing barrel strap nut, unscrew and remove the nut.

(*b*) Withdraw barrel strap bolt, remove gun pivot and barrel strap.

(*c*) Slide the barrel and gas cylinder forward to disengage them from the front end of the body and detach the gas cylinder.

(*d*) Withdraw split pin and unscrew flash eliminator.

(*e*) Withdraw split pin and unscrew gas plug.

NOTE.—The port is not normally to be removed from the gas plug for cleaning. This may be satisfactorily cleaned by the use of a specially shaped scraper.

To Assemble the Barrel Group:—

(*a*) Screw in gas plug and insert split pin.

(*b*) Screw on flash eliminator and insert split pin.

(*c*) Attach gas cylinder to the spigot on gas block and insert breech end of barrel and gas cylinder into their housings in the body.

(*d*) Slide the barrel strap downwards on to the lands of the breech casing, attach the gun pivot and secure the assembly by the barrel strap bolt, nut and split pin.

To Assemble the Piston Rod, Breech Block, Return Springs and Body Extension.

(*a*) Place Breech Block on the piston rod projection and insert into body; depress feed piece and push the assembly forward.

(*b*) Assemble return springs on rod and insert assembly into piston rod housing.

(*c*) Enter return spring rod into buffer recess, attach body extension and secure by pressing securing pins right home.

(*d*) Replace gun sights.

Detailed Stripping of Groups and Parts:

To Strip the Body Extension. (This is only to be done if a component part is broken):—

(*a*) Remove the body extension from the gun.

(*b*) Remove split pin, unscrew and withdraw spade grip frame bolts.

(*c*) Withdraw the spade grip.

(*d*) Drift out sear buffer spring sleeve cap securing pin and unscrew sear buffer spring sleeve cap.

(*e*) Remove sear buffer spring and sear buffer.

(*f*) Drift out sear lever axis pin and remove sear lever.

(*g*) Press out sear axis pin and remove sear.

(*h*) Drift out sear catch axis pin and remove sear catch.

(*i*) Drift out the trigger axis pin.

(*j*) Withdraw the trigger, trigger connecting rod spring sleeve, cap and sear catch spring.

To assemble, reverse the above order, observing the following points:—

(i) When inserting the trigger assembly into its housing, the return spring rod should be used to depress the sear spring clear of the trigger connecting rod spring sleeve stop.

(ii) Ensure that the sear spring is positioned beneath the step of the sear.

To Strip the Safety Catch. (This is only to be done when a part is broken):—

(*a*) Remove top securing screw of side pieces.

(*b*) Remove safety catch, plunger, spring and plunger guide from the thumbpiece.

Assemble the safety catch components, using a "pilot" pin before inserting into spade grip.

To Strip the Breech Block:

(*a*) Unscrew and remove firing pin screw and remove firing pin and firing pin spring.

(*b*) Ease forward and remove extractor spring and remove extractor.

(*c*) Drift out feed piece axis pin and remove feed piece, plunger and spring.

To assemble, reverse the above order.

To Remove the Ejector:

(*a*) Ensure that the breech block is in its forward position.

(*b*) Pull back and remove the ejector cover from its housing.

(*c*) Rotate the ejector nose outwards until the ejector trunnions can be withdrawn from the bearing slots in the ejector housing, and remove the ejector.

To Replace the Ejector:

(*a*) Ensure that the breech block is in its forward position.

(*b*) Insert the tail of the ejector into the ejector housing and engage the trunnions on the ejector with the bearing slots in the ejector housing.

(*c*) Rotate the ejector nose until it lies inside the ejector housing.

(*d*) Slide the ejector cover into the recess from the rear of the ejector housing and push into recess.

To Remove the Cocking Handle:

(*a*) Withdraw split pin, remove cocking handle lug pin and remove cocking handle lug.

(*b*) Pull cocking handle back to the rear of the cocking handle slide slot, and lift out the cocking handle and slide from its slot.

Assemble in reverse order.

To Strip the Magazine:

(*a*) Remove the Retaining Pin.

(*b*) Turn the driver "clockwise" to disengage the inner spring anchorage and remove.

(*c*) Insert dummy cartridge under each retaining spring so that springs are just clear of spacer plate.

(*d*) Lift off spacer and remove the dummy round and spring.

NOTE.—Care must be taken to ensure that the spacer plate retaining springs are not distorted by the insertion of improper tools. By inserting a dummy cartridge as far as the "neck", the springs will be forced sufficiently clear of the spacer plate to facilitate easy removal.

To Assemble the Magazine:

(*a*) Place the dummy round and spring in the body.

(*b*) Place the Spacer Plate in position, ensuring that the dummy round lies between two spacers.

(*c*) Remove the dummy cartridge to allow retaining springs to secure spacer plate.

(*d*) Insert the driver, turn clockwise and insert retaining (split) pin (short arm uppermost).

Loading and Unloading Magazines.

To Load and Prepare a Magazine (hand filling):—

(*a*) Withdraw retaining pin and remove the driver.

(*b*) Rotate the spacer plate until the dummy round is visible against the cartridge body guide.

(*c*) Slide the first cartridge, base first, into the lips, keeping the cartridge as parallel to the bottom plate as possible.

(*d*) Turn the spacer plate until the next space appears and repeat with remaining cartridges as for (*c*) until no further rotation of the spacer is possible.

(*e*) Insert the driver and turn "*anti-clockwise*" to engage spring anchorage.

(*f*) Place magazine on winding plate and with winding handle turn the driver 3½ turns for 60 rounds magazine; 4½ turns for 100 rounds magazine, and insert retaining pin.

To Unload a Magazine:—

(*a*) Place the magazine on winding plate.

(*b*) With the winding handle assembled, remove the retaining pin and ease off all spring tension.

(*c*) Remove driver and spacer plate and empty live rounds from magazine body and assemble magazine.

Mechanism.

To Load the Gun:—

(*a*) Put safety catch to "Safe".

(*b*) Pull back cocking handle to the rear to cock gun and return cocking handle to its forward position.

(*c*) Place magazine (front catch first) in position on the breech casing and give upward pull to ensure security.

(*d*) Set the safety catch to fire.

The gun is now loaded and ready to fire.

Cocking by Hand.—On the cocking handle being pulled backwards, the cocking handle catch is disengaged from the recess in the body and allows the cocking handle to be drawn to the rear. The cocking handle lug engages against the rear of the slot in the left side of the piston rod. The piston rod is thus drawn to the rear, carrying with it the breech block, until the bent on the underside of the piston rod is engaged by the sear. During this movement of the piston rod the return springs are compressed. The cocking handle must now be returned to its forward position. The gun is then ready to fire.

Forward Movement:—

(*a*) *Release of the Sear.*—When the trigger is pressed, the short arm forces the trigger connecting rod forward and compresses the trigger connecting rod spring. The forked forward end of the trigger connecting rod being engaged against the lower arm of the sear, rotates the sear on its axis pin, compressing the sear spring and withdrawing the nose of the sear from the bent on the underside of the piston. Meanwhile, the head of the sear catch has been forced forward by the sear catch spring until its two upper arms have engaged over the "step" on the sear, thus preventing the sear from rising until the trigger has been fully released. When the nose of the sear is disengaged from the bent on the piston rod, the piston rod is forced forward by the compressed return springs, carrying with it the breech block.

(*b*) *Feeding of the Round from Magazine to Chamber.*—As the breech block moves forward, the feed piece engages against the base of the cartridge held in the lips of the magazine, forcing the bullet end of the cartridge under the front of the bullet guide and feed piece cam, guiding the bullet into the chamber and there deflecting the base of the cartridge downward on to the face of the breech block where it is engaged by the extractor. The final forward movement of the breech block forces the cartridge fully home into the chamber.

(*c*) *Action of the Magazine.*—Immediately each cartridge is clear of the lips of the magazine, the remainder of the cartridges in the magazine are moved round bodily by the action of the driving spring acting on the spacer plate until the next round is positioned in the magazine lip ready for the next feed action.

(*d*) *Locking of the Breech Block.*—When the breech block reaches the end of its forward movement, the piston rod continues to move forward and the lower inclined surface on the rear of the piston rod bears against the corresponding inclined surface on the rear of the breech block, forcing the rear of the breech block up until it engages in front of the locking shoulder in the breech casing. The piston rod still continues to move forward, and the horizontal surface at its rear bears against the underside of the breech block, thus retaining the breech block in its locked position, in front of the locking shoulder.

(*e*) *Firing of the Cartridge.*—During its final forward movement, the front of the piston rod projection strikes the firing pin, forcing it forward and compressing the firing pin spring; the nose of the firing pin protrudes through the firing pin hole in the face of the breech block and strikes the cap of the cartridge in the chamber. The piston rod finally comes to rest against the piston rod stops in the body.

Backward Movement:—

(*a*) *Action of the Gases.*—On the cartridge being fired and after the bullet has passed the gas vent in the barrel, a portion of the gases escapes through the vent into the gas block and is deflected by the groove in the port into the gas cylinder, where it impinges on the head of the piston rod, driving the piston rod to the rear, and compressing the return spring.

(*b*) *Backward Movement of Piston and Unlocking of the Breech.*—As the piston rod is driven to the rear, the front of the piston rod projection is disengaged from the rear of the firing pin, which is withdrawn by the firing pin spring. At this time, the horizontal surface at the rear of the piston rod is still bearing against the underside of the rear of the breech block ensuring that the breech block remains in the locked position until the bulk of the gases have escaped from the barrel.

As the piston rod moves further to the rear, the upper inclined surface on the rear of the piston rod projection bears against the corresponding inclined surface inside and at the rear of the breech block, forcing the rear of the breech block down, and out of engagement with the locking shoulder. The piston rod now carries the breech block to the rear until the piston rod is brought to rest against the buffer on the body extension.

(*c*) *Extraction and Ejection.*—As the breech block moves to the rear, the claw of the extractor, being engaged in front of the rim of the empty case in the chamber, withdraws the empty case.

The cam groove on the left of the breech block now bears against the tail of the ejector, rotating the ejector on its trunnions and forcing the nose of the ejector inwards into the slot at the front of the breech block, where it engages behind the base of the empty case held by the extractor. The empty case is then jerked out of engagement with the extractor through the ejection opening on the right side of the body through the deflector into the deflector bag.

During the backward movement of the breech block the feed piece is forced down by the round held in the lips of the magazine. As soon as the feed piece is clear of this round it rises under the influence of the feed piece spring and plunger to its normal position.

Engagement of the Sear:—

When the trigger is released, the trigger and trigger connecting rod are forced back to their normal positions by the trigger connecting rod spring, thus freeing the forked end of the trigger connecting rod from the lower arm of the sear. The sear, however, is still unable to rise until the trigger connecting rod has almost reached the limit of its backward movement, when two small lugs on the trigger connecting rod bear against the sear catch and rotate it to the rear, disengaging the two upper arms of the catch from the step on the rear of the sear. The sear is now forced up into its normal position by the sear spring. The sear is now free to engage in the bent on the piston rod as the piston commences its forward movement. The shock of the impact between the sear and the piston bent is absorbed by the sear buffer spring, through the medium of the sear lever, and sear buffer.

Firing Action.

Assuming the gun to be loaded, if the trigger is pressed and the pressure maintained, the gun should continue to fire until either the trigger is released or the last round fed from the magazine.

To Unload the Gun.

(*a*) With the palm of the hand press forward the rear magazine catch flap, and with the fingers of the same hand grasp the leather handle and lift the magazine rear end first from the gun.

(*b*) If the breech block is held to the rear, press the trigger, pull back cocking handle and return it to forward position; press trigger, or

(*c*) If the breech block is in the forward position, pull back cocking handle and return to the forward position; press trigger.

The gun is now unloaded.

Action of the Safety Catch.

On rotating the safety catch thumbpiece to the "Safe" position, the safety catch is lowered and engages with the step on the trigger, thus preventing movement of the trigger.

When rotated to the "Fire" position, the safety catch is raised clear of the trigger, allowing free movement.

NOTE.—The action of applying the "Safety Catch" does not prevent the gun being cocked.

Operations before, between and after Flights.

(A.P. 1641B, Vol. II., Chapter 2.)

GROUP "A": OPERATIONS BEFORE FLIGHT WHEN FIRING IS TO TAKE PLACE.

1. Inspect gun, attachments and mounting for security and freedom of movement.
2. Clean and dry barrel, gas plug and gas cylinder, ensuring that gas cylinder has freedom of movement.

3. Ensure flash eliminator and gas plug are screwed home and body extension securing pins are secure.
4. Test safety catch and magazine catches for efficiency.
5. Ensure all split pins are in position and opened.
6. Clean and oil moving parts and working surfaces.
7. See deflector bag is secure.
8. Check correct functioning of gun.
9. Check gun sights for security and damage, and reflector sights for correct functioning.
10. See that the spare part wallet is complete and correctly secured.
11. Inspect, fill and correctly tension the magazines. Ensure that magazines are secured to their pegs.

NOTE.—Where ~~A.G.S.~~ split pins are removed, they should always be replaced by new ones.

GROUP "B": BETWEEN FLIGHTS WHEN FIRING HAS TAKEN PLACE.

1. See that gun is unloaded.
2. Empty and inspect deflector bags, check empty cases and remove unfired rounds.
3. Obtain firer's report and exchange parts as necessary.
4. Clean barrel, flash eliminator and gas affected parts.
5. Clean and oil all working parts.
6. Check correct functioning of gun.
7. Check reflector sight for correct functioning.
8. Check security of gun, its attachments and mounting.
9. Check fresh magazines for correct tension and security on pegs.

GROUP "C": OPERATIONS AT THE END OF A DAY'S FLYING IF FIRING HAS TAKEN PLACE.

1. See that gun is unloaded; ~~check for unfired rounds and obtain firer's report~~.
2. Remove gun from aircraft as soon as possible and take to armoury for cleaning.

3. Strip the gun for cleaning and treat as follows:—

(*a*) *Barrel* ... ... *Flash Eliminator* ... *Gas Plug*	Boil, dry and remove all fouling. Oil bore and wipe exterior of parts with oily rag.
(*b*) *Gas Cylinder* ... ... *Piston Rod*	Boil, dry and remove fouling and oil.
(*c*) *Breech Block*	Remove fouling; wash in petrol, dry and oil.
(*d*) *Body Extension*	Wash in petrol and oil. Wipe exterior with oily rag.
(*e*) *Body*	Remove any fouling, clean, dry and oil.
(*f*) *General*	Clean all parts not referred to in detail with oily rag.

4. Examine components as follows and exchange parts as necessary:

(*a*) *Barrel*	(i) For cuts, metallic fouling and corrosion.
	(ii) Gas block, gas plug and port for fouling and loose fit.
	(iii) Front magazine catch for efficiency.
	(iv) Test bore and chamber for wear.
(*b*) *Gas cylinders and piston rod*	(i) View for straightness.
	(ii) Remove all burrs.
	(iii) Insure that the piston-rod moves freely.
	(iv) Examine for fractures and burrs.
	(v) Examine the bent for wear.

(*c*) *Breach Block*:—	
Body	(i) Remove all burrs and examine for cracks at rear end of piston recess.
	(ii) Inspect firing pin hole for damage.
Extractor ...	(iii) Examine claw for fractures.
	(iv) Change spring if defective.
Feed piece ...	(v) Examine axis pin, if loose exchange.
	(vi) Change the spring if broken.
Firing pin ...	(vii) Examine for fractures and score marks.
	(viii) See that the pin is not bent.
	(ix) Examine spring for efficiency.
(*a*) *Body Extension*	(i) Examine for cracks near the holes for securing pins.
	(ii) Examine buffer and buffer spring.
	(iii) Examine axis pins. (must be firm).
(*e*) *Body*	(i) Examine for crack and burrs.
	(ii) Test rear magazine catch for efficiency.
	(iii) Ensure deflector bag catch brackets are secure.
	(iv) Examine efficiency of body extension securing pins.

(*f*) *General*	(i) Exchange damaged parts as necessary.
	(ii) Fit magazine and test loading and ejection using *drill cartridges*.
	(iii) Complete gun history sheet.

Inspection of Magazines.

Visual Examination :—

1. *Body.*

   Cartridge partition for dents and burrs.
   Cartridge and bullet guide for defects and burrs.
   Catch piece for burrs.
   Spring clips for serviceability.

2. *Spacer Plate.*

   Spacers for damage.
   Rim for dents and burrs.
   Driving spring for defects and security to outer anchorage.

3. *Dummy Round and Spring.*

   Security of spring.

4. *Driver.*

   Spring anchorage.
   Leather handle for condition and security.

Tests after Assembly :—

1. Ensure spring clips retain spacer plate securely.
2. Ensure spacer plate rotates freely.
3. Ensure that driver engages driving spring correctly.

Gauging of Magazines :—

See separate instruction (A.P. 1641B " Instructions for maintenance of the Mk. I Vickers Magazine " refers).

Test after Examination of Gun.

To Test the Efficiency of Feed and Ejection :

Fit a new magazine, loaded with good drill cartridges, and operate cocking handle and trigger.

Ensure that loading and ejection take place smoothly.

Care in Handling.

1. The gun must be handled carefully to avoid damage. Careless handling will probably result in complete stoppage of the gun during firing.

2. Whenever the cleaning rod is to be used to clean the barrel, the breech block must first be removed to prevent burring of the striker-hole by the end of the rod.

Cleaning and Storage.

1. *Preliminary Cleaning.*—As set out in " Operations between Flights, when Firing has taken place " (vide A.P. 1641B, Vol. II, Chap. 2, Group " B ").

2. *Principal Cleaning.*—As set out in " Operations after Flight, when Firing has taken place " (vide A.P. 1641B, Vol. II, Chap. 2, Group " C ").

3. *Subsequent Cleaning.*—Where guns have been fired and cleaned and are not to be used again immediately but stored in Armoury, the barrels and gas affected parts are to be cleaned and oiled daily for a period of 10 consecutive days. Failure to do this will inevitably results in these parts becoming rusty through " sweating ".

4. Guns that are kept in the armoury, which *may be required* for use at short notice, are to be stripped and cleaned each week and left lightly oiled with Oil Anti-Freezing (Type " A "). They are to be stored with the tension of the return springs removed, covered up in racks or in gun chests in a horizontal position.

5. Guns that are kept in the armoury, which are *not required* for use at short notice, are to be kept in their chest and are to be treated as follows:—

(i) All unpainted steel surfaces are to be coated with a thin coating of mineral jelly.

(ii) Barrels are to be filled with a mixture of 95 per cent. Mineral Jelly and 5 per cent. Beeswax, which should be applied in fluid state by heating.

(iii) Breech blocks are to be dipped in mineral jelly (heated).

These guns are to be stripped, cleaned, examined and regreased once every six months, a note to this effect being made on the label attached to the gun.

Life of Parts.

Estimated life of

Return springs	30,000 rounds.
Buffer springs	10,000 rounds.

Gauges for use with Vickers Gas Operated Gun.

Cartridge Head Space	·074 inch.
Barrel Gauges	·301 inch.
	·307 inch.
	·308 inch.
	·310 inch.
	Lead No. 2.

Special Tools for use with Vickers Gas Operated Gun.

(*a*) Combination Tool.
(*b*) Gas plug spanner.
(*c*) Brush, cleaning, barrel.
(*d*) Brush, cleaning, bore.
(*e*) Magazine winding plate and handle.
(*f*) Plug, clearing (for removal of separated cases).

South African Air Force Standard Notes

ARMAMENT

SECTION "G"
CHAPTER VI

GUN, BROWNING ·303 in.
(RECOIL)

Printed in the Union of South Africa by the Government Printer, Pretoria
1939

U.P.S. 11846—1939—1,000

ARMAMENT SECTION "C".

CHAPTER VI.

GUN, BROWNING, ·303 IN. (RECOIL).

INSTRUCTIONAL EQUIPMENT.

(*a*) Gun, Browning, complete A/C Mk. II.

(*b*) Mounting Machine Gun Mk. IV.

(*c*) Tools, cleaning, M.A. Browning S. IE/5121.
Tools, combination, ·303″ M.G. Browning IE/5120.

(*d*) Sear rear Pneumatic Release Units 7A/1127.
Units, Fire and Safe, Pneumatic 7A/1133.
Units, Fire and Safe, Hand Operated 7A/NIV.

(*e*) Browning Links and Dummy Cartridges (10).

(*f*) Rods, Cleaning and Flannelette.

ARMAMENT SECTION "C".

CHAPTER VI.

GUN, BROWNING, ·303 IN. (RECOIL).

SYLLABUS.

Classroom Instruction.	*Lecture.*	*Page.*
(*a*) General Description and Names of Parts	1 & 2	1–5
(*b*) Stripping and Assembly	3	5
(*c*) Mechanism	4, 5, 6	6–12
(*d*) Mechanism by Pupils	7 & 8	—
(*e*) Breeching up the Barrel	9 & 10	12–14
(*f*) Revision of (*e*) Barrel	11 & 12	—
(*g*) Adjustments changing Belt Feed Direction	13 & 14	15
(*h*) Operations, before, between and after Flight	15	17
(*i*) Revision	16	—
Range Practice.		
Practical Belt Filling, Range Practices, Cleaning and Storing the Gun	17 & 18	—

GUN, BROWNING, ·303 IN.

General Description.

Weight (with loading mechanism and special trigger motor) (14 ozs.)	22 lb. 12 ozs.
Overall length of gun (with flash eliminator)	3 ft. 8½ in.
Length of barrel	24 inches.
Number of grooves	5.
Bore	·303 inches.
Rate of fire (approx.)	1,150 r.p.m.
Twist of rifling	Left hand.

Description of Parts.

The parts of the gun may be divided into two groups:—

(i) The recoiling portions.

(ii) The non-recoiling portions.

The main groups falling under these two headings are as follows:—

(i) *The Recoiling Portions:*—

(*a*) Barrel group (consisting of barrel and barrel extension).

(*b*) Breech block.

(ii) *The non-Recoiling Portions:*—

(*a*) Barrel casing.

(*b*) Breech casing.

(*c*) Back plate.

(*d*) Body cover.

(*e*) Lock frame.

(*f*) Return spring.

Names of Parts.

The following description of parts gives the names and uses of the different components falling under each group. Where the symbol (F) follows a name, it denotes that it is not in itself a gun component, but simply a feature of a main group. Such features are formed

either by machining, or by permanent fixing to the main component by riveting, etc.:—

(i) *Recoiling Portions.*

(*a*) *Barrel Group:*—

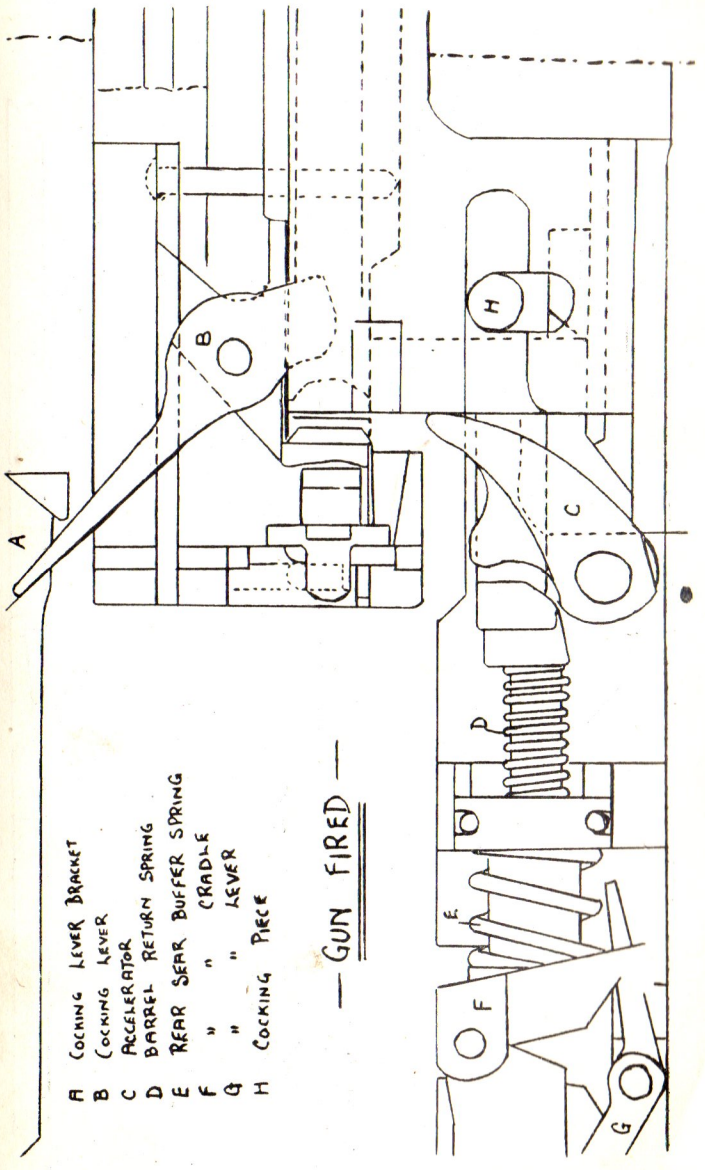
Barrel.	Locking notches (F). Air cooling rings (F) (On Mk. I barrels only).
Barrel Extension.	Ejector top clearances (F). Ejector side clearances (F). Tang (F). Boss (F). Barrel extension stud (F). Barrel locking spring. Locking piece. Locking piece pin. Locking piece cam grooves (F). Recesses for trigger motor push rod (F). Breech block guide grooves (F).

(*b*) *Breech Block:*—

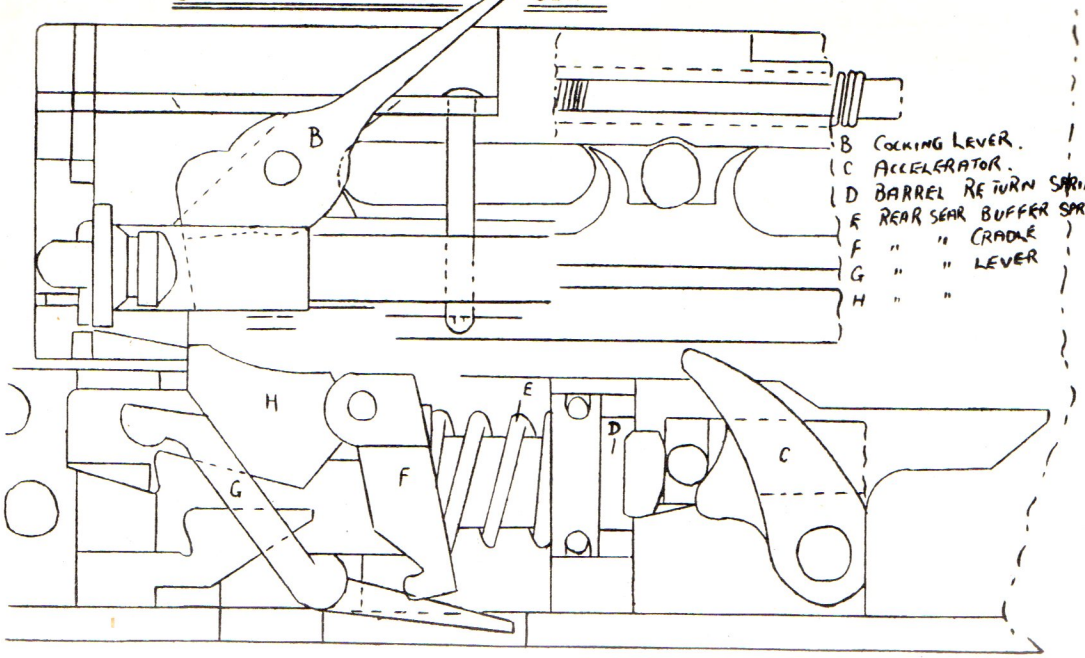
Breech block.	Cocking stud housing (F).
Cartridge face (F).	Guide ribs (F).
Accelerator face (F).	Sear housing (F).
Extractor stop (F).	Sear retainer housing (F).
Recesses for trigger motor push rod (F).	Switch plate housing (F).
Cam grooves (F).	Extractor housing (F).
Locking recess (F).	Firing pin housing (F).
Return spring housing (F).	Sear spring retainer keeper housing.
	Cocking stud pin (F).

Firing Pin:

Firing pin spring pin.	Firing pin spring housing (F).
Bents (F).	Cocking lever slot (F).
Firing pin spring.	Striker (F).

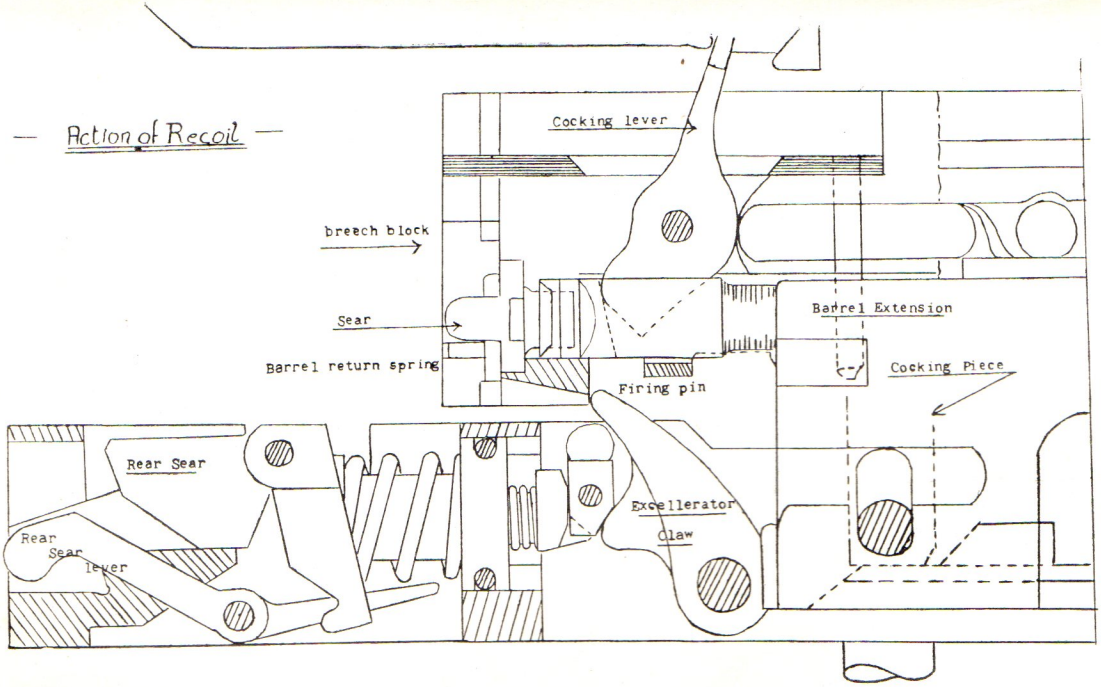


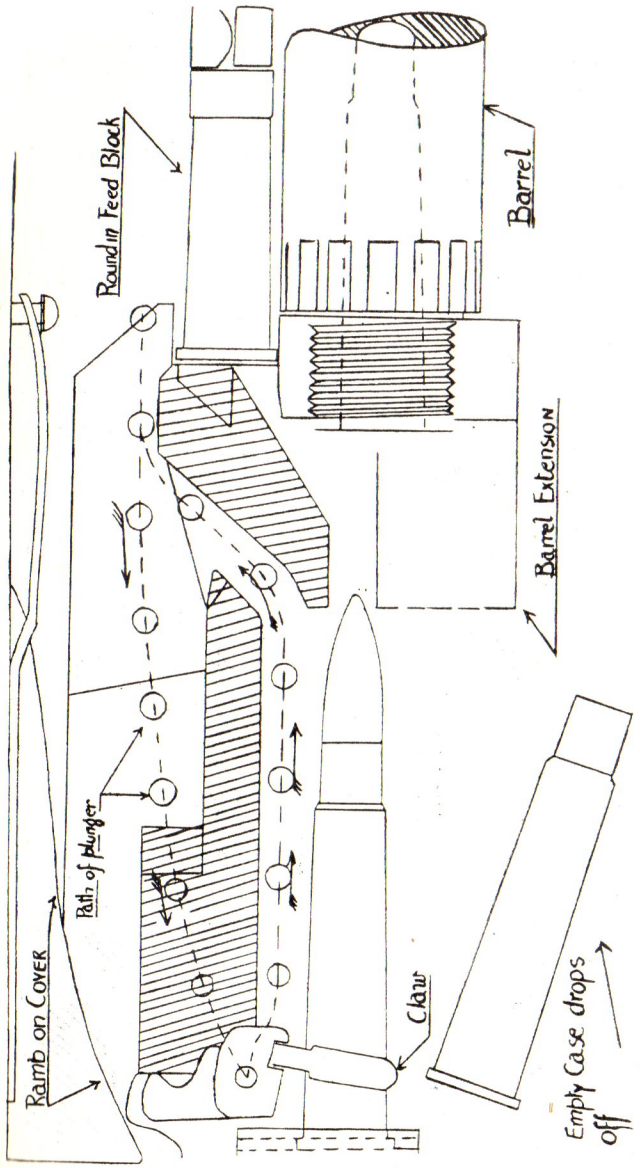
— OPERATION OF REAR SEAR —



B Cocking Lever.
C Accelerator.
D Barrel Return Spring
E Rear Sear Buffer Spring
F " " Cradle
G " " Lever
H " "

— Action of Recoil —





Bear position of breech block showing path of extractor.

Switch Plate :

Plunger. Spring.

Cocking Lever :

Nose (F). Tail (F). Pin.

Sear :

Bent (F). Spring housing (F).
Spring. Sear spring retainer keeper and pin.
Sear retainer. Stud (F).
Sear spring retainer and head. Sear retainer stops (F).

~~*Extractor* :~~ TRANSPORTER.

Arm (F). Plunger spring and pin.
Horn(F). Ejector.
Claw (F). Ejector spring.
Plunger. Ejector pin.

Cocking Stud :

(ii) *Non-Recoiling Portions.*

(*a*) *Barrel Casing :—*

Muzzle attachment. Flash eliminator.
Front barrel bearing (F). Flash eliminator washer. (Mk. I // only.)
M.A. chamber (F).

(*b*) *Breech Casing :—*

Trunnion block. Breech block guide rib (F) (2).
Rear barrel bearing (F). Joint cover and detent pawl housing (F).
Lock frame grooves (F). Detent pawl.
Cocking stud slots (F) (2). Detent pawl spring.
Trigger motor slots (F) (2).

Left Side Plate (F) :—

~~Extractor~~ TRANSPORTER cam (F). Retainer hole (F).
~~Extractor~~ guide (F).

Right Side Plate (F) :—

Return spring rod recess (F).

Bottom Plate (F):—

Locking piece cam.
Operating slots (F) (2).
Interrupted flanges (F).

Top Plate (F):—

Cocking lever bracket (F).

Feed Opening (F):—

Retaining pawl.
Retaining pawl spring.
Retaining pawl pin (2).
Cartridge stop.
Bullet stop.
Filling piece.
Chute lugs.

(c) *Back Plate*:—

Catch and pin.
Plunger catch spring.
Catch plunger.
Buffer discs (22 in number).
Buffer.
Tube buffer (F).
Buffer tube screw.
Buffer tube screw plunger.
Buffer tube plunger spring.

(d) *Body Cover*:—

Rachet teeth (F).
Pin.
Recess (F).
Feed lever plunger and spring.
Extractor guide ramp (F).
Cover catch.
Feed lever axis stud.
Cover extractor spring.
Cover catch spring.
Feed lever.
Cover extractor spring stud (F).
Cover catch axis pin with lever.

The Slide:

Filling piece.
Feed pawl pin.
Feed pawl extension.
Guide ribs (F).
Feed pawl.
Feed pawl spring.
Recesses (F).
Feed pawl extension pin.

(e) *Lock Frame*:

Projections (F).
Accelerator stop (F).
Accelerator.
Barrel return spring socket pins (2).
Lock frame retainer tube stud.

Accelerator pin.
Accelerator claw (F).
Accelerator shoulders (F).
Frame guide ribs (F).
Barrel return spring.
Barrel return spring plunger.
Barrel return spring plunger guide (F).
Barrel return spring socket.
Rear sear.
Rear sear spring.
Rear sear plunger.
Rear sear pin.
Rear sear cradle.
Rear sear lever.
Rear sear lever pin.
Rear sear buffer spring.
Rear sear buffer spring washer.
Lock frame retainer
Lock frame retainer tube.
Lock frame retainer spring.

(f) *Return Spring*:—

Rod.
Stop pin (F).
Collar.
Head (F).

Stripping and Assembling.

1. Stripping for cleaning.

2. Stripping for examination, repairs or adjustments.

1. *Stripping for Cleaning*:—

Raise cover and see that gun is clear; remove flash eliminator, back plate, return spring, cocking stud, breech block, lock frame and barrel assembly; separate lock frame from barrel extension.

To Assemble.—With cover raised, insert barrel assembly with lock frame attached, insert breech block (with cocking lever forward) and cocking stud, depress rear sear and push parts forward, replace return spring, back plate, close the cover.

NOTE (i) To separate lock frame, grip it in the right hand and barrel in left, trip the accelerator with right thumb.

To Assemble.—Hold parts in the same way, seeing that:—

(*a*) Accelerator claws lie upwards between rear of extension and the boss on the extension tang.

(*b*) Lock frame projections enter slots in barrel extension.

(*c*) Barrel extension stud engages barrel return spring plunger.

Push on lock frame to rotate accelerator and lock parts together.

(ii) The breech block components will only be stripped for cleaning after firing.

To Strip Breech Block.—" Ease " firing pin spring. Remove the extractor, switch plate with plunger and spring, cocking lever pin, cocking lever, sear spring retainer keeper, sear spring retainer, sear spring, sear retainer, sear, firing pin.

Assemble in reverse order; check assembly by " cocking " and " firing ".

2. *Stripping for Examination, Repairs or Adjustments.*

Normally, components will only be stripped in detail, as necessary.

Mechanism.

Loading the Gun:—

(*a*) *To Insert the Belt.*—~~Raise the cover and~~ place the first cartridge against the cartridge and bullet stops, ~~Engage the extractor claw~~. Close the cover.

engaged by belt retaining pawl

(*b*) *To Load.*—Operate loading mechanism fully to the rear, then re-position it right forward. The gun is then fully loaded; the breech block being held to the rear by the rear sear, a round being held on the breech block face in line with the chamber.

Unloading the Gun:—

(*a*) *To Unload.*—Raise the cover. Operate the loading mechanism fully to the rear. Raise the extractor with the forefinger, allowing the cartridge supported by the ejector to drop through the ejection opening.

(*b*) *To Remove the Belt.*—Remove the belt from the feed opening. Replace the loading mechanism in its forward position. Operate the control to allow the breech block to go forward. Close the cover.

(i) *Backward Movement.*

This consists of the following operations:—

(*a*) *Action of Recoil.*—When a round is fired, recoil action takes place and gas is momentarily trapped in the muzzle attachment. These combined forces drive the barrel to the rear. The Barrel carries with it the barrel extension and the breech block, the latter being locked to the barrel extension, due to the fact that the locking piece is held upwards by the locking piece cam. The barrel extension boss forces the barrel return spring plunger backwards and compresses the barrel return spring.

(*b*) *Unlocking of the Breech Block.*—As the barrel moves backwards, the locking piece pin strikes the slanting surfaces of the lock frame projections and forces the locking piece down the slope of the locking piece cam. The locking piece is thus withdrawn from the locking recess in the breech block and the breech block is unlocked from the barrel extension.

(*c*) *Backward Rotation of Accelerator.*—During recoil action, the barrel extension bears against the front of the accelerator, and rotates the accelerator backwards as far as the accelerator stop. During this movement, the shoulders of the accelerator engage in front of the boss on the barrel extension tang, and hold the barrel extension and barrel to the rear.

(*d*) *Backward Movement of the Breech Block.*—As the accelerator rotates backwards, its claws bear against the accelerator face of the breech block, and drive the breech block to the rear. During the backward travel of the breech block, the return spring is compressed, and actions (*e*), (*f*) and (*g*) take place.

(*e*) *Backward Action of the Extractor.*—When the gun is in the fired position, the claw of the extractor is engaged in front of the rim of the cartridge against the cartridge and bullet stops. As the breech block and extractor travel backwards, this round is withdrawn from the belt and carried to the rear, being supported by the ejector. The extractor is prevented

from falling owing to its plunger riding along the top of the extractor cam. On reaching the chamfered face of the extractor guide, the extractor plunger is depressed. The ramp on the cover then forces the extractor down and carries the live round fully on to the cartridge face of the breech block.

(*f*) *Extraction and Ejection.*—The empty case in the chamber is held by the flanges on the breech block face. Thus, as the breech block travels backwards, the case is withdrawn from the chamber. Being unsupported it is free to fall off the breech block face, when sufficiently clear of the barrel. If the empty case has not already fallen off, positive ejection will take place during the downward movement of the extractor [paragraph (*e*)]. The rim of the live round bears on the rim of the empty case and forces the empty case off the face of the breech block. In the case of the last round in the belt, its empty case, if not already fallen off, will be ejected by the ejector.

(*g*) *Cocking Action.*—The tail of the cocking lever lies in the cocking lever bracket. When the breech block moves backwards, the cocking lever is rotated on its axis and its nose draws the firing pin to the rear and compresses the firing pin spring. The bent of the firing pin bears against the sear and compresses the sear spring. The sear, under the influence of its spring, returns, ready to engage the bent when the cocking lever rotates in the forward movement.

(*h*) *First Action of Belt Feed.*—The stud on the feed lever is engaged in a cam groove on top of the breech block. Therefore as the breech block travels backwards, the feed lever is rotated on its axis. The nose of the feed lever being engaged in a recess of the feed slide, moves the slide across the belt. The feed pawl rides over the round held by the retaining pawl and by the action of the pawl spring engages that round ready for feeding. During the whole of this action, the belt is prevented from leaving the gun by the retaining pawl and spring.

(ii) *Forward Movement.*

(*a*) *Action of Return Spring and Buffer.*—On completion of the backward movement, the return spring is fully compressed, and any surplus energy from recoil is absorbed by the buffer discs. Thus the force of recoil is expended, and the return spring is able to drive the breech block forward.

(*b*) *Second Action of Belt Feed.*—As the breech block moves forward, the stud on the feed lever moves in its cam groove and rotates the feed lever. This causes the feed slide to feed in the belt so that a live round is brought against the cartridge and bullet stops. During this movement, the retaining pawl and spring are depressed by the next live round, and then, under pressure from its spring, the pawl rises and engages behind that round.

(*c*) *Forward Movement of the Breech Block.*—During forward travel of the breech block, actions (*d*), (*e*) and (*f*) take place.

(*d*) *Forward Action of the Extractor:*—

1. *Feeding of Round.*—As the breech block travels forward, the extractor plunger rides down the sloping face of the extractor guide until the extractor arm reaches the extractor stop. During this downward movement, the live round is brought into line with the chamber and firing pin hole. The round is still supported by the ejector. With continued forward movement of the breech block, the live round is fed into the chamber.

2. *Raising of the Extractor.*—When the ejector is brought abreast of the ejector slide clearance in the barrel extension, the extractor plunger starts to ride up the extractor cam. This causes the extractor to rise and so lifts the ejector clear of the live rounds, the ejector being forced outwards by the contour of the cartridge case.

When clear of the round, the ejector spring returns the ejector to its normal position. As the extractor reaches its fully forward position, its claw rides over the rim of the live round in the belt, and under

pressure from the cover extractor spring, engages in front of it.

At the same time, the ejector, under the influence of its spring, embraces the case of the round, ready to support it, when later it is withdrawn from the belt. In this position, the nose of the ejector rests in a groove on top of the barrel extension.

(*e*) *Forward Rotation of the Accelerator.*—When the accelerator face of the breech block strikes the claws of the accelerator, the latter is rotated forward. The accelerator shoulders become disengaged from the barrel extension boss, and the barrel and the barrel extension are thus free to be driven forward by the barrel return spring.

(*f*) *Return of the Cocking Lever.*—During the forward travel of the breech block, the tail of the cocking lever engages in the cocking lever bracket, and causes rotation of the cocking lever. This rotation resets the lever for cocking, engages the bents of the sear and firing pin, and at the same time gives clearance for the firing pin to travel forward when released.

(*g*) *Locking of the Breech Block.*—As the barrel moves forward under the influence of the barrel return spring, the barrel extension moves away from the lock frame projections. This leaves the locking piece free to move upwards when the breech block is home and the breech closed. The locking piece being forced upwards by the slope of the locking piece cam, enters the locking recess of the breech block and so locks the breech block to the barrel extension.

(*h*) *Firing of the Cartridge.*—When the breech block is right forward, i.e., the breech locked, the lower lug of the sear is brought into line with the rear end of the trigger motor push rod slot. The push rod is thus able to strike the sear and drive it inwards. The sear bent disengages from the firing pin bent, the firing pin is carried forward by its spring and strikes the cap of the cartridge.

(*j*) *Operation of the Rear Sear.*—On ceasing to operate the controls, the rear sear lever is

released, allowing the rear sear to rise. Thus, on the backward movement of the breech block —obtained as the result of the firing of the last cartridge—the rear of the breech block depresses the rear sear, which is then forced upwards again by its spring when clear of the accelerator face. On the breech block being forced forward by the return spring, its forward movement is arrested by the accelerator face engaging the bent of the rear sear. The shock of the engagement between breech block and sear is absorbed by the buffer spring.

Should the breech block strike the rear sear before it has fully risen resulting in a partial engagement of the bents, as the rear sear is carried forward in this low position a projection towards the rear strikes an inclined ramp and forces the bents into full engagement.

NOTE.—The partial forward movement of the breech block has caused the extractor to force the last cartridge withdrawn from the belt on to the breech block face and in line with the chamber.

Operation of the Fire Control.—On operating the control, the rear sear is depressed, allowing the return spring to carry the breech block fully forward. The trigger motor push rod then acts on the sear and releases the firing pin.

Trigger Motor.

1. *Special Features.*—The " T " piece can be altered for angular position by loosening the locking ring, so freeing four ribs from recesses in the body. When set as required, the " T " piece is clamped by tightening the ring.

The push rod is attached to the trigger motor plunger, the joint allowing lateral movement of the push rod. The push rod plunger and spring, housed in the trigger motor bracket, tend to keep the push rod in alignment with the trigger motor plunger.

2. *Action.*—The operation of the trigger motor is similar to that of the Vickers Gun. Contact between the sear and push rod may occur in two ways:—

(*a*) With the breech block fully forward, the push rod makes direct contact on the sear lug.

(*b*) If the push rod is protruding when the breech block goes forward, the sear lug deflects it, compressing the push rod plunger spring. The impulse being spent, the push rod is withdrawn by the trigger motor spring and returned to its normal alignment by the push rod plunger and spring. The succeeding wave then actuates the push rod as in (*a*).

Adjustments.

Breeching up the Barrel:—

(i) Breeching up is the term applied to the correct positioning of the breech end of the barrel in relation to the front of the breech block when the breech locking piece is fully engaged in the locking recess.

(ii) As the efficiency of the gun depends to a great extent on the accuracy with which this adjustment is carried out, it is essential that great care is exercised by the armourer.

(iii) When breeching up, ensure that there is no dummy cartridge or empty case in the chamber.

(iv) Assuming the gun to be completely assembled, the following sequence of operations is to be complied with:—

(*a*) Raise the gun cover.

(*b*) Remove the back plate and withdraw the return spring.

(*c*) Remove the cocking stud and withdraw the breech block.

(*d*) Remove the extractor (transporter), switch plate, plunger and spring, cocking lever and pin from the breech block.

(*e*) Withdraw the recoiling portions to the rear until the locking notches of the barrel are about 2 inches clear of the breech casing.

(*f*) Remove the lock frame from the barrel extension.

(*g*) Holding the barrel and barrel extension, disengage the barrel locking spring, resting the spring on the lower side of the barrel extension.

(*h*) Unscrew the barrel (clockwise) not less than a quarter turn.

(*i*) Assemble the breech block (less components) to the barrel extension.

(*j*) Rotate the assembled barrel, barrel extension and breech block together through 180° and ensure that the "locking piece" is fully engaged in the locking recess.

(*k*) Holding the locking piece in full engagement, carefully screw in the barrel until the breech end is felt to bear against the front of the breech block.

(*l*) Release the barrel locking spring so that the projection engages in the adjacent locking notch.

If a notch is not co-incident with the projection, rotate the barrel clockwise (unscrew) until engagement with the next notch is obtained.

NOTE.—The locking spring is in no circumstances to be deformed to obtain engagement in a notch.

(*m*) Push the assembly fully home in the gun and ensure that the front end of the barrel extension bears against the trunnion block.

(*n*) Hold the barrel extension firmly in this position by the thumb and test for any *fore and aft* movement of the breech block.

NOTE.—Care must be taken that permissible lateral and vertical movement is not confused with fore and aft movement.

(*o*) If fore and aft movement is present, withdraw the assembly, remove the breech block and screw in the barrel (anti-clockwise) one notch.

(*p*) Re-test assembly in gun for fore and aft movement as in (*n*) and repeat (*o*) as necessary until fore and aft movement has been eliminated.

(*q*) Test adjustment for "over-breeching" by placing the assembled portions in the gun and push fully home into position. Only a normal

pressure should be necessary to do this, and any difficulty experienced in doing this indicates that the gun may be over-breeched, i.e. that the locking piece cannot rise into engagement with the locking recess.

NOTE.—The barrel is not to be removed from the barrel extension except to replace the barrel.

Adjustments.

Changing Belt Feed Direction.—The gun is adaptable for right or left hand feed in aircraft as required. To convert the gun for " change of feed direction ", certain parts of the gun require re-positioning.

To prepare a gun for right hand feed, the components are positioned as follows:—

(*a*) *Breech Block:*—

(i) *Switch Plate.*—Position with groove connecting left hand front and right hand rear cam grooves in breech block.

(ii) *Ejector.*—Assemble with nose and spring to the left of the extractor face.

(*b*) *Feed Opening:*—

(iii) *Retaining Pawl.*—On right hand side of feed opening.

(iv) *Cartridge Stop.*—in rear slot on left hand side of feed opening.

(v) *Filling Piece.*—Opposite retaining pawl.

(vi) *Bullet Stop.*—In front slot on left side of feed opening.

(*c*) *Cover:*—

(vii) *Feed Pawl Extension.*—Assembled to the pawl so that the extension is to the left and uppermost when the slide is inserted in the body cover.

(viii) *Slide Filling Piece.*—In the recess in the slide to the front of the gun.

(ix) *Feed Slide.*—Inserted in the body cover after assembly, with the nose of the feed pawl to the left,

(x) *Feed Lever.*—Assembled to body cover with the plunger and spring in lower hole of lever.

Test assembled gun after completion of adjustment by inserting belt of dummy cartridges and operating loading mechanism to load the gun.

Adjustments.

Trigger Motor and Loading Mechanism:—

(i) After fitting, the trigger motor needs no adjustment, being located in position by the projection on the trigger motor bracket and the locking stud.

The locking stud nut must be kept tight. Over-tightening, however, is liable to strain the trigger motor bracket.

(ii) The actual position of the trigger motor and loading mechanism on the gun will depend on the installation requirements of the gun in the aircraft.

Care, Cleaning, etc.

General Instructions for Handling, etc.:—

1. Only the tools authorised are to be used.
2. The gun must not be lifted or carried by the barrel casing.
3. When removing the flash eliminator, the muzzle attachment is to be held by a second spanner to avoid distortion.
4. When inserting recoiling portions, avoid damage to the barrel muzzle and rear barrel bearing.
5. The breech block must be forward when closing the cover. The cover is intended to close stiffly and should be tapped down with the palm of the hand.
6. The buffer must be kept screwed tight.

Cleaning of Barrels.—Barrels are to be cleaned in accordance with the appropriate technical handbook.

Inspection of the Gun.—Details of inspections to be carried out will be found in Unit Maintenance Orders.

The following instructions are, however, issued as a guide to the inspections to be carried out:—

Care, Cleaning etc.

Daily Inspection of Gun:—

1. Remove breech block.
2. Clean and re-oil the bore.
3. Clean and re-oil breech block, barrel extension lock frame and feed mechanism.
4. Inspect gun for security on mounting.
5. Inspect ammunition tanks for security and correct alignment.

Before Firing:—

1. Remove all oil from bore, muzzle attachment and flash eliminator.
2. Oil frictional parts lightly with a mixture of oil, anti-freezing and paraffin (50/50).
3. Check mechanism for correct assembly and smooth working.

After Firing:

1. Ensure gun is unloaded.
2. Strip and clean the gun as laid down. (See "Stripping for Cleaning".)
3. Re-assemble with all parts lightly oiled.
4. Operate loading mechanism to check for correct assembly and operation of the gun.

Points to be noted during Cleaning:—

(i) When cleaning the muzzle attachment use special tool supplied.

(ii) All hard fouling must be removed from the muzzle, flash eliminator and front barrel bearing. Chromium plating is only to be cleaned with paraffin. No abrasive material is to be used.

(iii) Special attention must be paid to the barrel and all gas-affected parts for 10 days after firing.

Tools required for Stripping and Assembling.

Tool.	*Uses.*
Braces, carpenters, with adapter.	Removing and replacing buffer tube screw.
Bits, stock, bolt.	Removing and replacing buffer tube screw.

Tool.	*Uses.*
Hammers, rubber.	Removing and replacing loading mechanism.
Pliers, flatnose.	Removing and replacing split pins, etc.
Screwdriver, small.	Removing and replacing split pins, etc.
Cartridges, dummy.	Removing feed lever and cover extractor spring.
Tools, combination.	Removing and replacing firing pin spring, ejector.
Spanner "C" Special.	Removing and replacing T.M. body locking ring.
Spanner, D.E., $^{7}/_{16}$ in., $^{9}/_{16}$ in.	Removing and replacing T.M. bracket stud nut. Restraining muzzle attachment.
Spanner, D.E. $\frac{1}{2}$ in.; $^{7}/_{16}$ in.	Removing and replacing flash eliminator.
Spanner, D.E., $\frac{3}{8}$ in.; $^{5}/_{16}$ in.	Removing and replacing T.M. pipe line connectors, plunger cap plug, "T" piece plug. Removing and replacing loading mechanism lock nut.
Spanners, adjustable.	Removing and replacing locking piece cam nut.
Drift No. 5.	Removing firing pin spring fixing pin; trigger motor plunger fixing pins; trigger motor push rod plunger or fixing pins.
Drift No. 6.	Stripping breech block, etc.
Drift No. 7.	Removing and replacing feed pawl pin.
Drift No. 8.	Removing and replacing rear sear lever pin.
Drift, $\frac{3}{8}$ in., copper faced.	Removing and replacing loading mechanism.
Tools, cleaning.	Muzzle attachment chamber.

Differences between Mk. I // and Mk. II Guns.

1. Front mounting integral with trunnion block.

2. Slide modified—filling piece deleted.

3. Feed lever modified—head re-shaped to fit modified slide. Stud re-shaped to conform with and give improved bearing in cam slots in breech block.

4. Loading lever modified.

5. Firing pin and sear—angle of engaging faces modified. Modified components marked with " + ".

No 134

South African Air Force Standard Notes

ARMAMENT

Section "G"

Chapter VII.

Printed in the Union of South Africa by the Government Printer, Pretoria.
1939
U.P.S.11847—1939—1,000.

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G.P.S. 11847—1939—1,000.

ARMAMENT SECTION "G"

CHAPTER VII.

1. The accompanying Orders are promulgated to ensure that armament equipment of the South African Air Force is maintained efficiently.

2. Any recommendations for the amendment of these orders, which may be found to be desirable as a result of experience, should be put forward immediately, so that the maintenance of armament equipment may be further improved.

W. T. B. TASKER,
Lt.-Col.,

O.C. Training Command, S.A.A.F.

11847—2

ARMAMENT.

SECTION G.

CHAPTER VII.

ARMAMENT MAINTENANCE SCHEDULES.

GUNNERY.

SECTION 1A. Pneumatic Firing Gear.
,, 1B. Hydraulic Firing Gear.
,, 1C. C.C. Gear, Camera Gun, Signal Pistol, Gun Sights, Gun Mountings.
SECTION 2. Browning Gun.
,, 3. Vickers Gun Mks. II, III and V.
,, 4. Lewis Gun Mks. III A, B, C, D, E and F.
,, 5. Vickers Gun. Gas operated.
,, 6. Armament Orders.

BOMBING EQUIPMENT.

SECTION 1. Electro Magnetic Bomb Carriers.
,, 2. Electro Magnetic Bomb Release Systems.

SECTION 1A.

DUNLOP PNEUMATIC GEAR.

GENERAL INFORMATION.

Instructions for Maintenance.

1. This system is pneumatically operated, the necessary air pressure being obtained from a compressor driven by the aeroplane engine and stored in suitable containers at either 200 or 300 lb. per square inch pressure. It is applied chiefly to outboard guns as fitted on the Hurricane aeroplane, but may also be applied to cockpit guns firing through synchronising gear as fitted on Hartbees aeroplanes. In the former case, the firing mechanism is attached to the gun itself; in the second, it is attached to the base of the C.C. reservoir.

2. It is *most important* that before any maintenance inspections are begun, guns should be unloaded and all live ammunition removed, as both pneumatic and hydraulic firing control mechanism have reservoirs that retain pressure after the compressor or pump has ceased to function.

This constitutes a danger, in that operation of the firing button or trigger will cause a loaded gun to fire.

3. Ordinary flying time stipulations will not apply entirely, as the inspections are mainly for deterioration of rubber washers and dirt on the valves, both being independent of amount of use. Some flying time inspections are, however, given.

4. The air pressure required for the operation of the mechanism is 120-200 lb. per square inch. When a 300-lb. compressor is fitted on the engine, a reducing valve is necessary and is incorporated between the air containers and firing button and this gives 150 lb. pressure in the system, otherwise the pressure in the mechanism is as shown on the triple indicator gauge for the general air system of the aeroplane.

5. Tests for leaks should be conducted by smearing a suspected part with soapy water.

6. Minor leaks in the pipe line from the firing button to the gun, when the button is depressed are not important. There is no pressure in the pipe line from the firing button to gun when button is not depressed but there is always the same pressure in the pipe line between the container and firing button as exists in the container, subject to the action of the reducing valve when fitted.

7. The whole system, i.e., joints, firing button and firing mechanism should be kept clean and free from oil and foreign matter. *Special precautions* must be taken to this end when any part is being dismantled or repaired.

8. Faulty firing mechanism or reducing valve should be exchanged or repaired in the armoury.

9. In the case of Browning guns there are two firing mechanisms on each gun (the rear sear release unit and the fire and safe unit), in the case of Vickers guns, there is one unit only, i.e., the pneumatic trigger motor.

10. When Browning guns are operated through C.C. gear the rear sear release unit (pneumatically operated) is, as always, on the gun but the fire and safe unit is

replaced by the hydraulically operated trigger motor controlled through a pneumatic device fitted to the base of the oil reservoir. Vickers guns have the trigger motor with its pneumatic control only.

SECTION 1B.

GROUP A.

Inspections Daily Irrespective of Firing.

A. 1. See that the pressure is maintained as indicated by the triple gauge; if fall in pressure is shown there may be a leak in the pipe line from the air container or in the firing button, each of which should be checked. (Maintenance of the button para. F. 2 to 5.)

A. 2. Examine the firing button and pipe lines for security, especially at the flexible pipe connections at the foot of the control column and at the bulkhead unions.

A. 3. Check to see that the firing mechanisms are properly attached to the guns.

A. 4. When connecting the length of armoured hose attaching the firing mechanism to the fixed pipe line, no more than finger pressure should be used on the wing nuts, which should be locked by a wire to any convenient and fixed point.

A. 5. Whenever the wing nut connection is broken, the rubber ring should be exchanged. On no account should the working life of a rubber ring be allowed to exceed 6 months, irrespective of flying time. This also applies to pneumatic control connections of the synchronising gear.

GROUP B.

Operations before each day's Flying when the Gun is to be Fired.

B. 1. Check functioning of control mechanisms as follows:—

(*a*) *Outboard Browning Guns.*—Cock the guns and then press the firing button. Each breech block should immediately return to the firing

position and the firing pin should be protruding. If, owing to the position of the guns, firing pins are not visible when the top cover is lifted a drill cartridge with its percussion cap recess filled with grease on tinman's solder should be put in the breech block before the test is done. The impression of the firing pin, if this is functioning correctly will be seen in the grease or soap or solder after the test and removal of the cartridge.

Failure of the gun to fire may be due to:—

(i) Faulty attachment of the firing units to the Gun.

(ii) A fault in the gun or the firing control mechanism.

(iii) Leakage in the pipe lines.

(iv) Foreign matter in the pipe lines probably at or near unions causing a stoppage.

(v) Leakage at the firing button.

(*b*) *Synchronising Gear Guns.*—Pull up the oil reservoir handle and open the petty air release valve. Upon depression of the firing button the reservoir handle should return under the action of its spring and, in the case of Browning Guns only (Hartbees Installation) the near sear release should function at the moment the firing button is pressed.

N.B.—The above tests do not check the correct functioning of the gear itself, for which see A.P. 1242, Chap. 9, paras. 40 and 43 to 44.

GROUP C.

Operations at the End of the Day's Flying if Firing has taken place and Guns are being Removed for Cleaning.

C. 1. When guns are being removed from the aeroplane the fixed air pipe lines must be closed with blanking nuts provided. The rubber washer of which should be examined for serviceability.

GROUP D.

Inspection every 20 Hours.

D. 1. Drain the air filter. If any oil has blown out of the drain hole the air container should be removed from the aeroplane and cleaned.

NOTE.—When replacing the air container see that the pipes enter not less than 4 inches.

D. 2. Check gun isolating valves for leaks as follows:—

With the guns or blanking caps of the pipe line in position and with the valve levers in the firing position (i.e. flat against the petty air release valve) depress the firing button and listen for leaks or note any appreciable drop on the triple pressure gauge. Repeat this with first one and then the other valve lever in the firing position.

An opening of the closing spring with a pair of pliers will cure a leak at the exhaust; otherwise the leak is due to dirt and the valve will need dismantling.

GROUP E.

Inspection every Three Months.

E. 1. Remove the firing button and clean its face with a rag.

E. 2. Remove the cup leathers from the units specified below. If hard, exchange, and before replacing the leather, whether new or used, soak it in neat's-foot oil (Stores Ref. 34B/99). Care must be taken to avoid excessive wear of gland nuts where fitted.

The synchronising gear unit.
Vickers gun pneumatic control.
Camera gun pneumatic control.

NOTE.—When reassembling the camera gun unit the adjusting nut should be set so that when the firing button is depressed, the end of the stroke of the unit is limited by the nut and *not* by the working parts of the camera. Thus the operating levers on the camera should still have a little play after the shutter has been released.

GROUP F.

F. 1. With exception of the firing button and the gun isolating valves, individual units of the system

should *not* be given maintenance on the aeroplane other than that indicated above. In the event of failure they should be exchanged for a spare part and repaired in the armoury or depot.

Firing Button.

F. 2. When the firing button is inspected for leaks, partial dismantling may be necessary for verification.

F. 3. To dismantle the button, the locking pin at the back should first be removed and the front of the button then unscrewed.

The inside of the button is now exposed and a suspected leak in the inlet valve may be verified by smearing a small amount of soapy water on the face of the seat. If a leakage is confirmed the seat should be removed and the valve will then be exposed (this will of course involve escape of air from the air container). Dirt and small particles of metal on the valve seat may then be cleaned away, but if there are particles of metal embedded in the valve seat, the whole valve should be exchanged.

F. 4. Leakage at the firing button when the button is depressed may be due to the valve seat not being screwed home or to the lead or fibre ring joint not being airtight. If cleaning does not remedy the defect the joint ring should be exchanged.

F. 5. Special tools are required for dismantling the firing button, namely, one double pronged key and one valve key.

Gun Isolating Valve.

F. 6. To dismantle this valve first detach it from the base board and then remove the retaining screw, after which the retaining mechanism of the valve may be removed. Clean the valve seat and examine it for damage. If damaged the seat should be exchanged, otherwise cleaning should rectify any leakage.

F. 7. If the test for leakage before dismantling has shown a leak with the valve lever in the up position, the fault is at the inlet valve which, when the isolating valve is dismantled, may be withdrawn by means of the key and the rubber seat may then be examined for damage and cleaned. If the rubber seat has particles of metal

imbedded in it the valve core should be exchanged. No lubrication should be applied to any part of the valve.

SECTION 1B

HYDRAULIC GEAR.

General Information.

1. This system is hydraulically operated, the necessary oil pressure being obtained from a pump on the engine which also supplies the power for operating the turrets in which guns controlled by Palmer Mechanism are installed.

2. In the case of Browning Guns there are sometimes two hydraulic units on each gun, a rear sear release fire and safe unit; in other cases only the near sear is unit hydraulically operated, e.g. Hartbees Installation. The fire and safe unit type hand operated is sometimes employed on outboard guns on Hurricane and Spitfire installations.

Vickers G.O. Gun installed in turrets, e.g. Bristol Blenheim Bomber, have one unit only for operation of the sear and is similar to the near sear unit of the Browning Gun.

3. It is *most important* that before any Maintenance Inspections are begun the guns must be unloaded and all live ammunition removed.

4. If serious leaks or other faults develop in any unit, this should be exchanged and repaired in the armoury.

5. A runaway gun may be due to:—

(i) Control valve stuck open.
(ii) Control valve return spring broken.
(iii) Broken spring in rear sear release.
(iv) Seizure of the rear sear release piston.

NOTES.—In the case of Browning Guns with hydraulically operated fire and safe units, e.g. trigger motors (iii) and (iv) above will result in the guns stopping with the recoiling portions in the forward position.

GROUP A.

Inspection Daily.

A. 1. Inspect the Units and Pipe Lines of the system for security and cleanliness.

A. 2. See that the firing mechanisms are properly attached to the guns.

NOTE.—One half of each mechanism is attached to the gun and is removed with the gun when this is taken from the aeroplane; the other half is at the Armoured hose and remains on the aeroplane when the gun is removed.

A. 3. When the guns are removed, see that the armoured hose connections are securely fastened down with insulation tape or string and *not* metal wire.

GROUP B.

Operations Before each Day's Flying when the Gun is to be Fired.

B. 1. Verify that adequate pressure is being delivered to the system.

NOTES.—(i) This can be determined by noting that the accumulator piston rod is extended:—e.g. that 1½-2 in. of the rod is visible.

(ii) The oil pressure should be provided by the engine pump with the aeroplane engine running or by the portable service equipment.

(iii) If the portable service equipment is used great care must be taken to avoid ingress of foreign matter into the pipe lines and also to ensure that only the correct fluid is used.

B. 2. Examine the system generally for fluid leakage, tightening union nuts as necessary.

B. 3. Inspect the gland of the control valve, for leakage. Any necessary tightening of the gland nut must be done with discretion since excess pressure may cause stiffness in the operation of the control.

NOTE.—Slight seepage may be ignored. Failure to stop a serious leak by tightening of the gland nut indicates necessity for a new gland washer.

B. 4. Inspect the head of the accumulator for leakage. Any sign of fluid at this point or at the breather hole indicates failure of the piston washer.

NOTE.—A small, leak may rectify itself through spreading of the piston washer, when the system is put under pressure.

B. 5. Inspect the rear sear release and fire and safe units (if fitted) for leakage. Any sign of fluid here indicates failure of the piston washer.

NOTE.—This may disappear after operation. To obtain pressure for this test operate the trigger.

B. 6. Examine the flexible armoured hose to the guns for kinks or damage: if any of the armoured strands are broken change the connection.

B. 7. Ensure that the firing mechanisms are correctly attached to the gun, especially that the pipe line quick release is right home and that the lock catch is properly engaged in one of the grooves of the interrupted flange.

B. 8. Check the functioning of the control valve return spring.

NOTE.—This can be done by operating the trigger a few times and noting upon release that the control valve piston rod returns to its original position. There is normally a clearance between the bowden cable shackle and the gland nut.

B. 9. Check the functioning of the system by operating the cocking mechanism of the guns and pressing the firing trigger, when the breech blocks should fly forward and the firing pins be released.

NOTES.—(i) If owing to the position of the Browning guns, the firing pins are not visible when the top cover is lifted, a drill cartridge with its percussion cap recess filled with grease or soap or tinman's solder should be put in the breech block before the test is done. The impression of the firing pin if this is functioning correctly will be seen in the grease or soap or solder after the test and removal of the cartridge.

(ii) Repeat this operation after the power has been discontinued, i.e. engine stopped, when the guns should fire from the energy stored in the accumulator. The number of bursts which can be fired from

the accumulator alone depends entirely on the particular system, i.e. the number of guns and whether fire and safe units are fitted.

(iii) Failure of a gun to fire may be due to:—

(*a*) faulty attachment of the firing units to the gun.

(*b*) fault in the gun or in the firing control mechanism, e.g. seizure of the control valve piston or slack bowden cable.

(*c*) serious leakage in the pipe lines (in which event the whole turret may fail to function).

B. 10. Examine for security the attachments of the bowden cable to the firing trigger and to the control valve. Check the adjustment of the cable as necessary.

B. 11. Inspect the whole system and its units for cleanliness and corrosion.

GROUP D.

Inspection Every 20 Hours.

D. 1. Examine the rear sear release hand operating lever axis pin and spring for security, damage and corrosion. Lubricate as necessary. (Browning guns only.)

D. 2. Examine the lock catch axis pin and spring of each firing unit on the guns for security, damage and corrosion. Lubricate as necessary.

SECTION 1c.

Synchronising Gear: SG. 1-7.

SG. 1. Reservoir securely fitted. The wing-nuts of the reservoir brackets and the screws of the reservoir base must be firmly wired.

SG. 2. Air expelled from system.

SG. 3. System tested for faults (A.P. 1242. Chap. 9).

SG. 4. Control-cable, at the end engaged with the firing-levers, examined for fraying.

SG. 5. Control-cable locked, securely clipped clear of grease-nipple, allowing maximum movement of control-column.

SG. 6. Carry out rough check of timing by placing airscrew in correct position relative to the bore of the weapon, press control and rotate airscrew through an arc of 3 in. Whenever the blade of the airscrew is in the correct position, in relato the bore of the gun, the high-pressure piston-rod should lift slightly.

SG. 7. If necessary, add sufficient mixture to fill the gear.

Camera Gun, Type C. 22: CG. 1-8.

CG. 1. Mounting and gun rigid and locking-wires secure.

CG. 2. Examine the watch-lens set screw for tightness.

Revised Match, 1937.

CG. 3. Wind the watch and set it to the correct time.

CG. 4. Examine the bulb and battery for serviceability.

CG. 5. Clean the lens with the special cloth provided.

CG. 6. Cables examined for fraying and free-working.

CG. 7. Examine the loading-handle for security and the correct movement of the counter.

CG. 8. Test the functioning of the loading and firing actions.

Signal Pistol: P. 1-3.

P. 1. Pistol removed from its stowage, examined and screws tightened where necessary.

P. 2. Pistol lightly oiled, replaced in stowage and made secure.

P. 3. Signal cartridges made up to correct number.

Gun Sights: S. 1-2.

S. 1. Sights examined for security.

S. 2. Sights examined for serviceability.

Free Gun Mounting: M. 1-4.

M. 1. Mounting rigid, secure and free in rotation.

M. 2. Ensure that the control-cable adjustment locknuts are tightened.

M. 3. Examine the control-cable for fraying.

M. 4. Clean the mounting.

NOTE.—All moving portions of armament adjustment are to be lubricated. A thin film of oil G.P. Thin (Stores Ref. 34A 12) is to be applied to exposed portions, as protection against weather.

INSTRUCTIONS REGARDING ARMAMENT MAINTENANCE SCHEDULES.

Gunnery Equipment.

1. Inspection of armament equipment will be carried out by armourers in accordance with the inspection schedule attached hereto.

The schedules are divided into the following groups:—

Daily Inspection: (Fitted Armament).
Weekly Inspection: (Fitted Armament).
Weekly Inspection: (Stored Armament).
Six-monthly Inspection: (Stored Armament).
Special Inspection: (Fitted and Stored Armament).
Before Firing Inspection: (Fitted and Stored Armament).
After Firing Inspection: (Fitted and Stored Armament).

In order that the weekly inspection may be made to coincide whenever possible with airframe and engine periodic inspections, the inspection may be carried out at any time between the fifth and ninth day following the preceding weekly inspection.

NOTE.—The following defines the classification "Fitted and Stored Armament":—

(i) *Fitted Armament* includes all armament equipment which under normal conditions is permamently kept fitted on the aircraft.

(ii) *Stored Armament* includes all armament held on charge which is not normally kept permanently fitted to aircraft.

2. In addition to the above, tests and assembly of equipment on aircraft will be carried out as follows:—

Monthly.

(i) All fixed guns on aircraft will be fired on stop-butts.

(ii) All front gun sights will be harmonized.

Quarterly.

All aircraft will have its items of armament fitted and tested once a quarter, and the fact recorded in the airframe logbook.

3. *Records of Inspections, etc.*

(i) The following data will be recorded on Form 352 (gun history sheet):—

(*a*) Rounds fired.
(*b*) Mechanical breakages.
(*c*) Parts changed.
(*d*) Modifications embodied.
(*e*) Number of aircraft to which the gun is fitted (Vickers only).

NOTE.—Signature of Flight Commander will be obtained monthly.

(ii) *Form* 700.

A. *Daily Inspections.*

(i) The record of daily inspections of equipment fitted to aircraft will be recorded by the armourer's signature in column 20 of the front page of the Form.

(ii) Flight armament N.C.Os. will carry out a daily check inspection of a complete assembly-group at periods during each month. The assembly-groups will be selected in such a manner that, at the end of each month, each item of armament equipment will have received a daily check inspection. On the completion of the inspection, N.C.Os. will sign the Form 700, in column 33, against the group inspected, together with the date.

B. *Weekly Inspections.*

(i) Flight armourers will enter, in the place provided on Form 700, the record of weekly inspections, with their signatures.

(ii) Flight armament N.C.Os. will select assembly-groups and carry out a weekly check inspection.

The selection of these groups must be so arranged that, at the end of each month, every item of armament equipment will have received a weekly check inspection. On completion of the in-inspection. Flight Armament N.C.Os. will enter on Form 700 the group inspected, their signatures and the date.

(iii) *Armament Logbooks.*—All Flights will open and maintain logbooks containing the following detail:—

(*a*) Allocation of equipment.

(*b*) Record of mechanical defects; and in the case of guns, the number of rounds fired since the equipment was fitted.

(*c*) Record of all inspections carried out.

(iv) *Armament Modification Chart.*—A chart will be maintained in the Flight Armoury, showing:—

(*a*) Date leaflet received.

(*b*) Modification number.

(*c*) Logbook number.

(*d*) Leaflet number.

(*e*) Class.

(*f*) Allotted to aircraft number (equipment).

A code as under will be used, showing the true state of the equipment on charge:

" 1 " Spares on demand.
" 2 " Spares not available.
" 3 " Spares received.
" 4 " Modification incorporated.
" 5 " Permission not to incorporate applied for.
" 6 " Permission authorised.

To ensure that correct supervision and check is maintained, the Warrant Officer or Flight Armament N.C.O. will be personally responsible for the compilation of these records. The logbooks will be checked and initialled monthly by the Flight Commander.

4. Methods of gauging components and tolerances allowed are shown at pages 10, 11 and 12.

SECTION 2.

BROWNING GUN.

INSTRUCTIONS FOR MAINTENANCE.

GROUP A.

Operations before each Day's Flying when the Gun is to be Fired.

A. 1. Inspect the gun, its attachments and mounting for security.

A. 2. Ensure that the flash eliminator and muzzle attachment are clean and secure and that the split pin is in good condition and opened.

A. 3. Check the correct functioning of the gun.

NOTE.—This is done by fitting a few links and drill cartridges, operating the loading handle and ejection take place smoothly.

A. 4. Clean and dry the bore using the cleaning rod and flannelette.

A. 5. Clean and oil the moving parts and the working surfaces of the casing.

A. 6. Test the fire and safe and rear sear release units for efficiency.

A. 7. Inspect the ammunition box, empty cartridges case chute and line chute for security and correct alignment.

A. 8. Check the sights for security and in the case of reflector sights for continuity of circuit.

GROUP B.

Operations at the Inspection between Flights if Firing is taking place during Flight.

B. 1. Ensure that the gun is loaded.

B. 2. Check the security of the gun, its attachments and mounting.

B. 3. Obtain firer's report and if necessary make any exchanges.

B. 4. If any changes have been made check the Para. A. 3. correct functioning of the gun.

B. 5. Clean the bore using the single pull-through with gauze and flannelette which must be pulled through six times.

B. 6. Remove the flash eliminator and clear the fouling. Chapter 1, para. 9.

B. 7. Remove fouling from the muzzle attachment with the tool provided which must enter up to the shoulder.

B. 8. Remove any foreign matter from the inside of the breech casing and oil the working parts and surfaces.

B. 9. Inspect the ammunition box, empty cartridge case chute and link chute for damage, security and alignment.

B. 10. Empty the spent cartridge containers, if fitted.

B. 11. Check the empty cases and remove any misfired rounds.

B. 12. Examine the sights for damage, etc.

GROUP C.

Operations at the End of a Day's Flying if Firing has taken place.

C. 1. Ensure that the gun is unloaded.

C. 2. Remove the gun from the aeroplane as soon as possible after firing and take it to the armoury for cleaning.

C. 3. Dismantle the gun. Chap. 1. para. 9-25.

Barrel.

C. 4. Boil and dry.

C. 5. Inspect the bore for chemical corrosion and metallic fouling which, if present, must be removed.

C. 6. Try gauge plug, ·303 in. and if the gauge does not run repeat the de-nickelling process.

C. 7. Oil the bore.

C. 8. Wipe the exterior of the barrel with an oily rag. Ensure that the chromium plating is clean, but no abrasive material or metal polish must be used for the purpose.

Breech and Barrel Casings.

C. 9. Wipe the exterior with an oily rag.

Lock Frame.

C. 10. Do not remove the barrel return spring socket or rear sear cradle unless there are signs of rust. Wash in petrol and then oil thoroughly.

Breech Block, Barrel Extension and Flash Eliminator.

C. 11. Boil, dry and oil, except the firing pin, which must be washed in petrol.

C. 12. The flash eliminator is to be scraped to remove fouling, care being taken not to damage the chromium plating by using abrasive material or metal polish.

Feed Mechanism.

C. 13. Clean with an oily rag; dry and oil.

Return Spring.

C. 14. Wash in petrol and coat with oil.

Muzzle Attachment.

C. 15. This must be cleared, *in situ*, with the tool provided for the purpose; all fouling must be removed.

General.

C. 16. Examine parts for damage and exchange if necessary.

C. 17. Remove all burrs.

C. 18. By using scratch card or No. 00 emery cloth ensure that all signs of fouling are removed from the following parts:—

(i) Inside the breech casing near the breech of the gun.
(ii) Underside of the breech cover.
(iii) Front face of the breech block.
(iv) Firing pin and its housing in the breech block.
(v) Transporter.
(vi) Barrel extension.
(vii) Breech and muzzle faces of the barrel.

C. 19. Adjust the cartridge head space when reassembling the gun. Chap. 1. para. 68-76.

C. 20. Enter day's firing, breakages and any exchange of parts in the gun history sheet.

GROUP D.

Operations at the End of a Day's Flying when the Gun is Installed but has not been Fired.

D. 1. Ensure that the gun is unloaded.

D. 2. Check the security of the gun, its attachments and mounting and inspect for damage.

D. 3. Clean the bore, using cleaning rod and flannelette.

D. 4. If examination of the flannelette reveals the Group C presence of rust, the gun must be taken to the armoury to be stripped and cleaned.

D. 5. Oil the barrel and the working parts and wipe the exposed parts of the gun with any oily rag.

D. 6. Ensure that the muzzle attachment and flash eliminator are secure, that the split pin is in good condition and opened.

GROUP E.

Operations at the 120 Hour Inspection of the Aeroplane when the Gun is Installed but has not been Fired.

E. 1. Remove the gun from the aeroplane and take it to the armoury for cleaning. Group C.

E. 2. Check the correct functioning of the gun. Para. A 3.

E. 3. Inspect the ammunition box, empty cartridge chute and link chute for damage.

E. 4. Inspect the sights and ensure that they are clean and undamaged and in the case of reflector sights check for continuity of circuit.

GROUP F.

Operations after Firing 4,000-5,000 Rounds.

F. 1. Ensure that the gun is unloaded.

F. 2. Remove the gun from the aeroplane and take it to the armoury for cleaning. Group C.

F. 3. Dismantle the gun for examination. Chapt. 1, para. 32-57.

Barrel.

F. 4. Inspect for fractures, burrs, bulges and rust.

F. 5. Examine the bore for chemical corrosion and metallic fouling. If present, fouling must be removed.

F. 6. Examine the threads and notches at the breech end for burrs, which if present must be removed.

F. 7. Inspect the chromium plating at the muzzle. This should be smooth for the barrel to be serviceable.

F. 8. Test the bore and chamber by gauge for wear, fouling and damage.

F. 10. If a barrel has fractures, bulges or fails to pass F 8 or F 9 above it is unserviceable.

Barrel Extension.

F. 11. Examine for cracks especially near the trigger motor or fire and safe mechanisms plunger clearances.

F. 12. Remove all burrs.

F. 13. Test barrel locking spring for efficiency and exchange if loose or weak.

F. 14. Examine the breech block locking-piece and remove all burrs.

Breech Block.

F. 15. Examine the body and remove all burrs from the working surfaces and from the cartridge guides.

F. 16. Examine the following points for fractures.—

(i) Top of cartridge guides on the face of the block.

(ii) Rear top of the rear lightening recess.

(iii) Lower front face of the clearance for the cocking lever.

F. 17. Examine the following parts for wear.—

(i) Rear sear bent.

(ii) Front face of the locking recess.

(iii) Ends of the feed lever cam grooves.

(iv) Guide ribs.

F. 18. Engage a 0·064 in. gauge in the cartridge guides over the firing pin hole and test for wear with feeler gauges. If a 0·003 in. feeler enters, exchange the breech block.

Switch Plate.

F. 19. Remove all burrs from the grooves.

F. 20. Test for wear in its axis by inserting a feeler gauge between the plate and the top of its recess in the block (the transporter being in position). If a 0·03 in. gauge enters renew the switch plate and re-test. If the gauge still enters exchange the transporter.

Transporter.

F. 21. Examine the claw for cracks and remove any burrs.

F. 22. See that the rivet of the retaining plunger is tight. (Fitter armourer to tighten if necessary.)

F. 23. Examine ejector for fractures.

F. 24. Exchange ejector spring if weak or broken.

Firing Pin.

F. 25. See that the spring retaining pin is not proud.

F. 26. Examine the bents and remove all burrs.

F. 27. Examine for fractures and cracks.

F. 28. The springs should be removed by a fitter armourer and examined for damage, fractures and rust, and exchanged if necessary.

F. 29. Gauge the protrusion of the firing pin with the gauge provided. If it is excessive rub down the pin with the stone provided or No. 00. emery cloth, taking care to preserve the radius; if it is insufficient, exchange the pin.

Locking Lever.

F. 30. Remove all burrs.

F. 31. See that the axis pin is tight; if not, exchange it, do not attempt to open the split.

F. 32. When assembled and the firing pin is cocked the lever should remain in the forward position; if it does not, wear on the cocking lug is indicated.

Sear Mechanism.

F. 33. Remove all burrs.

F. 34. See that all parts fit correctly.

F. 35. Cock the firing pin and ensure that the sear is flush with the side of the breech block and that the cocking lever is free. Press on the cocking lever to withdraw further the firing pin and observe whether the sear moves outwards. If it does, exchange the firing pin or sear or both and repeat the test.

Return Spring.

F. 36. Examine for damage, fractures and rust.

F. 37. Exchange the spring if necessary.

Lock Frame.

F. 38. Examine for fractures.

F. 39. Examine the following parts for burrs which, if present, must be removed:—

(i) Guides.

(ii) Prongs.

(iii) Accelerator stop.

F. 40. Test the retainer plunger for efficiency and see that it is not bent.

Rear Sear.

F. 41. Remove all burrs from the face.

F. 42. Test efficiency of the plunger and spring; if sluggish, exchange the spring.

F. 43. Examine for cracks.

Rear Sear Lever.

F. 44. Remove all burrs and examine for fractures.

F. 45. Test for efficiency when assembled. Para. F. 72.

Rear Sear Cradle and Barrel Return Spring Socket.

F. 46. Examine for fractures and remove all burrs.

Accelerator.

F. 47. Remove all burrs from the claws and shoulder.

F. 48. Examine for fractures and wear.

Barrel Return Spring Plunger.

F. 49. Remove all burrs from the head of the plunger and guide pin.

F. 50. Examine the guide pin for wear and fit in its groove.

Barrel Return Spring.

F. 51. Examine for damage, fractures and rust.

F. 52. Exchange the spring, if necessary.

Rear Sear Buffer Spring.

F. 53. Examine for damage, fractures and rust.

F. 54. Exchange the spring, if necessary.

Breech Casing.

F. 55. Apply a straight edge to the breech cover, which change if distorted. Test the catch and detent for efficiency and, if not holding, exchange the

springs. Remove all burrs from the transporter ramp and see that the transporter spring is serviceable, if not exchange the spring.

F. 56. Examine the side plates for fractures near the flanges for the back plate, and if present exchange the gun.

F. 57. Remove all burrs, giving special attention to the front transporter cam on the left side plate.

F. 58. Ensure that the breech block locking piece cam is secure and that the split pin is in position. The nut must not be screwed up too tightly or stoppages will occur.

F. 59. Examine the rivets, in particular those of the feed opening brackets, and tighten up if necessary.

Feed Mechanism.

F. 60. Examine the feed lever for fractures and remove all burrs. Test the plunger and spring for efficiency; exchange the spring if necessary.

F. 61. Remove all burrs from the feed slide, test the feed pawl for efficiency and examine the leg for fractures. Exchange the pawl spring if necessary.

F. 62. Test the security of the cartridge and bullet stops and ensure that the retaining pawl is functioning correctly. Exchange the retaining pawl spring if necessary.

Back Plate.

F. 63. Test the catch for efficiency; exchange the spring if necessary.

F. 64. Ensure that the buffer is properly secured.

Barrel Casing.

F. 65. Inspect for external damage.

F. 66. See that the muzzle attachment is properly secured and free from rust and fouling.

F. 67. Examine the interior of the trunnion block and remove all burrs.

Miscellaneous.

F. 68. Examine all axis pins to see that they are tight and do not protrude; if loose the pin should be exchanged. Tighten the holes if necessary by lightly tapping around their edges with a small punch and hammer. (This is to be done by the fitter armourer.)

F. 69. Ensure that all retaining pins are properly secured split pins in position and opened.

F. 70. Exchange damaged parts as necessary and reassemble.

F. 71. Ensure that the barrel has been correctly breeched-up. Chap. 1, para. 68-76.

F. 72. *Rear Sear.*—Remove the back plate and open to the rear sear release, observe that the sear is drawn below the side plates of the lock frame. If not, exchange the rear sear lever and repeat the test. If it still projects exchange the rear sear.

F. 73. *Efficiency of the firing pin bent.*—Simulate recoil, three times firing off the rear sear. The firing pin should not be released; if it is, exchange the firing pin and repeat the test.

F. 74. *Test for wear in the feed mechanism.*—With the breech block home and the cover down apply the gauge provided through the feed opening until it is positioned between the cartridge and bullet stops and the feed pawl—there should be no movement. If the gauge is loose exchange the feed lever and repeat the test. If the gauge still moves, exchange the breech block, and if this does not remedy the defect, exchange the gun.

F. 75. *Efficiency of feed and ejection.*—Make up a belt of good drill cartridges and test by operating the loading handle and the rear sear release and noting that feed and ejection take place smoothly.

F. 76. *Defunctioning of the sear by the fire and safe unit.*—Simulate recoil, hold the loading handle and press the firing button. Allow the breech block to move forward slowly and see that the firing pin is not released until the gun is almost home, i.e. within ·09 in. If the firing pin is released the engagement of the plunger with the sear is incorrect. (This test should be carried out on the aeroplane.)

F. 77. Treat all unserviceable parts with preservative and affix labels.

F. 78. Complete the gun history sheet.

SECTION 3.

GUNS VICKERS MK. II, III ⅛ V.

CHAPTER I.

INSTRUCTIONS FOR MAINTENANCE.

GROUP A.

Operations before each Day's Flying when the Gun is to be Fired.

A. 1. Inspect the gun, its attachments and mounting for security.

A. 2. Ensure that the muzzle attachment is clean and dry, correctly assembled, and that the split pins are in good condition and opened. In the case of the Mk. II gun ensure that the muzzle attachment is correctly assembled, the rib of the locking bar is correctly positioned and that the locking lever is secured by its split pin.

A. 3. Fit lock and stow spare locks when available.

A. 4. Check the correct functioning of the gun.

NOTE.—This is done by fitting a few links and drill cartridges, operating the loading handle and observing that loading and ejection take place smoothly.

A. 5. Open the rear cover, rotate the crank handle and hand the lock on the steps at the rear of the side plate cams. Clean and dry the bore using the cleaning rod and flannelette.

A. 6. Clean and oil the moving parts, and the working surface of the casing.

A. 7. Inspect the ammunition box, empty cartridge case chute, and link chute for security and correct alignment.

A. 8. Check the sights for security and in the case of reflector sights for continuity of circuit.

GROUP B.

Operations at the Inspection between Flights if Firing is Taking Place during Flight.

B. 1. Ensure that the gun is unloaded.

B. 2. Empty the spent cartridge containers if fitted and check the empty cases and remove any misfired rounds.

B. 3. Check the security of the gun, its attachments and mounting.

B. 4. Remove the muzzle attachment and muzzle cup and clean the buffer spring with scratch card.

Remove fouling from the outside of the barrel just forward of the bearing in the end cap. Replace the buffer spring and fit a spare muzzle attachment.

B. 5. Obtain firer's report and if necessary make any exchanges.

B. 6. If any exchanges are made check the correct functioning of the gun.

B. 7. Remove the lock and clean it with an oily rag, dry and oil.

B. 8. Clean the bore, using the single pull-through, with gauze and flannelette, which must be pulled through six times.

B. 9. Remove any foreign matter from the inside of the breech casing, oil the working parts and surfaces and replace the lock.

B. 10. Inspect the ammunition box, empty cartridge case chute and link chute for damage, security and alignment.

B. 11. Examine the sights for damage, etc.

GROUP C.

Operations at the End of a Day's Flying if Firing has Taken Place.

C. 1. Ensure that the gun is unloaded.

C. 2. Remove the gun from the aeroplane as soon as possible after firing and take it to the armoury for cleaning.

C. 3. Dismantle the gun.

Barrel.

C. 4. Boil and dry.

C. 5. Inspect the bore for chemical corrosion and metallic fouling which, if present, must be removed.

C. 6. Try gauge plug ·303 in. and if the gauge does not run repeat the de-nickelling process.

C. 7. Oil the bore.

C. 8. Wipe the exterior of the barrel with an oily rag.

Breech and Barrel Casings.

C. 9. Remove any fouling from the barrel casing end cap using scratch card or No. 00 emery cloth.

C. 10. Clean the inside of the breech and remove any fouling using scratch card or No. 00 emery cloth.

C. 11. Wipe the exterior with an oily rag.

Muzzle Attachment. Muzzle Cup and Buffer Spring.

C. 12. Boil, dry and oil.

C. 13. If fouling is still present it must be removed with the tool provided for the purpose and by using scratch card or No. 00 emery cloth.

C. 14. In the case of Mk. II guns the cannelure in the muzzle attachment gland must be freed of residue.

Lock.

C. 15. Boil, dry and oil.

C. 16. If fouling is still present it must be removed with scratch card or No. 00 emery cloth.

Inner Side Plates.

C. 17. Boil, dry and oil.

C. 18. If fouling is still present it must be removed with scratch card or No. 00 emery cloth.

General.

C. 19. Components which have not been affected by gas are to be cleaned with any oily rag, dried and oiled.

C. 20. Examine parts for damage and exchange if necessary.

C. 21. Remove all burrs.

C. 22. After reassembling the lock verify that its spring weight is between 11 lb. and 14 lb.

C. 23. Check the gib spring using the 0·058 in. gauge.

C. 24. Check the height of the buffer spring.

C. 25. Check the weight of the fusee spring and adjust if necessary.

C. 26. When reassembling ensure that all parts are complete, split pins in position and opened.

C. 27. Enter day's firing, breakages and any exchange of parts in the gun history sheet.

GROUP D.

Operations at the End of a Day's Flying when the Gun is Installed but has not been Fired.

D. 1. Ensure that the gun is unloaded.

D. 2. Check the security of the gun, its attachments and mounting and inspect for damage.

D. 3. Hang the lock and clean the bore using the cleaning rod and flannelette.

D. 4. If examination of the flannelette reveals the presence of rust, the gun must be taken to the armoury to be dismantled and cleaned.

D. 5. Oil the barrel and the working parts and wipe the exposed parts of the gun with an oily rag.

D. 6. Ensure that the muzzle attachment is properly secured.

GROUP E.

Operation at the 120 Hour Inspection of the Aeroplane when the Gun is Installed but hot been Fired.

E. 1. Remove the gun from the aeroplane and take it to the armoury for cleaning.

E. 2. Check the gib spring using the 0·058 in. gauge.

E. 3. Check the weight of the fusee spring and adjust if necessary.

E. 4. Check the correct functioning of the gun.

E. 5. Inspect the ammunition box, empty cartridge case chute and link chute for damage.

E. 6. Inspect the sights and ensure that they are clean and undamaged and in the case of reflector sights check for continuity of circuit.

GROUP F.

Operations after Firing 2,000 ± 500 Rounds.

F. 1. Ensure that the gun is unloaded.

F. 2. Remove the gun from the aeroplane and take it to the armoury for cleaning.

F. 3. Dismantle the gun for examination.

Barrel.

F. 4. Inspect for fractures, burrs, bulges and rust.

F. 5. Examine the bore for chemical corrosion, and metallic fouling. If present, fouling must be removed.

F. 6. Examine the trunnions at the breech end for burrs which, if present, must be removed.

F. 7. Inspect the threads at the muzzle for damage and remove any burrs.

F. 8. Test the bore and chamber by gauge for wear, fouling and damage.

F. 9. View for straightness.

F. 10. If a barrel has fractures, bulges, or fails to pass F 8 or F 9 above, it is unserviceable.

Muzzle Cup.

F. 11. Examine for rust and burrs which, if present, must be removed.

F. 12. See that the threads are undamaged.

F. 13. Examine for cracks or flaws.

F. 14. Polish front face with stratch card or No. 00 emery cloth.

Buffer Spring.

F. 15. Remove any rust.

F. 16. Check height.

F. 17. If there is any sign of friction between the turns, exchange the spring.

Muzzle Attachment (Mks. III and V Guns).

F. 18. Examine the sleeve for distortion and ensure that it is an easy fit on the cylinder.

F. 19. Ensure that the plunger is free and that the split pins are not worn; exchange spring and split pins if necessary.

F. 20. Examine the vanes on the cylinder for distortion.

F. 21. Ensure that the flash eliminator is not loose. Exchange tab washer and tighten if necessary.

F. 22. Remove all burrs.

F. 23. Ensure that the grooves in the bullet exit holes are clean. Use special tool for the removal of any fouling.

Mk. II Guns.

F. 24. Remove all fouling, using scratch card or No. 00 emery cloth.

F. 25. Inspect the gland for damage to threads and flanges and remove all burrs.

F. 26. Ensure that the outer casing is not distorted and that it is a good easy fit on the gland. Examine for fractures and remove all burrs.

F. 27. Polish the inner face of the muzzle attachment cylinder, using scratch card or No. 00 emery cloth. Ensure that the cannelures in the bullet exit hole, and the gas escape holes are free of fouling.

F. 28. Examine the locking bar and lever for distortion, fracture and fit.

Trunnion Block.

F. 29. Examine the interior for burrs which, if present, must be removed.

Breech Casing.

F. 30. Ensure that the front cover catch holds the cover firmly. If there is any movement of the cover exchange the catch and if this does not remedy the defect, exchange the cover.

F. 31. Test the rear cover for efficiency.

F. 32. Test the extractor safety stop for efficiency and if necessary exchange the spring.

F. 33. Examine the extractor ramps on the rear cover and the cams on the side plates for burrs and scoring which, if present, must be removed. Ensure that the ramps are not loose.

F. 34. Examine the inner side plates for fractures and bend and remove all burrs.

F. 35. Examine the side plates of the casing for dents, and the corners of the slide recesses for cracks.

F. 36. Ensure that the retaining studs of the fusee spring box are not loose or damaged.

F. 37. Ensure that the roller is free to rotate and that it is properly secured; exchange the brass split pin if loose or worn.

F. 38. Ensure that the brackets of the loading handle and trigger motor are secure.

Crank and Connecting Rod.

F. 39. Examine for burrs which, if present, must be removed.

F. 40. Ensure that the connecting rod spring clip is secured and undamaged, and that the nut is tight.

F. 41. Ensure that the connecting rod pivots freely on the crank pin.

Crank Handle and Check Lever.

F. 42. Remove all burrs, and examine for fractures.

F. 43. Ensure that they are properly secured.

Fusee. Spring and Box.

F. 44. Examine the fusee and links for signs of distortion. Ensure that there is no sign of friction between the links.

F. 45. Test fit of feathers and lug in keyways and groove in the crank. Exchange if badly worn.

F. 46. See that the hooks of the spring are in good condition, the threads of the adjusting screw are in good order and that the pin is not bent.

F. 47. Examine the fusee spring box for cracks and see that the retaining hooks and fork are undamaged.

F. 48. Remove all burrs.

Rear Crosspiece.

F. 49. Examine for damage.

F. 50. Ensure that the T fixing pin is tight. Do not over-screw or the side plates may be distorted.

Feed Block.

F. 51. Remove all burrs.

F. 52. Test springs for efficiency and exchange if necessary.

F. 53. Ensure that there is no more than 1/16 in. vertical movement at the end of the top lever when both the top and bottom levers are assembled in the feed block. Excess movement indicates wear on the bottom lever pin or hole; check the length of the hole and if this is less than 0·93 in, the feed block must be exchanged.

F. 54. Test for wear of the top slide and its grooves in the feed block by placing the first and second fingers under the top pawls and pressing upwards, at the same time moving the slide backwards and forwards. If the top lever fouls the underside of the bridge of the feed block the top slide should be exchanged; if this does not remedy the defect, the feed block must be exchanged.

Mk. I Feed Block.

F. 55. Check the height of the top pawls by passing the T fixing pin (from the rear crosspiece) under them. If the T fixing pin passes under without raising them, the pawls should be exchanged.

Mk. II Feed Block.

F. 56. Enter a drill cartridge from the feed side and the lead of the case should just lift the top pawls.

F. 57. Test the bottom pawls for distortion by pressing on the lever and noting that both pawls are flush with the underside of the block at the same time.

Lock.

F. 58. Release the sear and keeping the side lever head fully depressed, test for vertical movement of the extractor. If there is any movement, try a new tumbler axis pin or exchange the extractor levers. If this does not remedy the defect, exchange the extractor or lock.

F. 59. Release the trigger and hold the lock with the fingers against the bottom of the extractor. Raise and lower the side lever head slightly and no downward movement of the extractor should take place. If the extractor moves, wear on the extractor stop is indicated. Allow the firing pin to move slowly forward to the firing position and note whether it has any tendency to force the extractor away from the stop. If it does there will be friction on the firing pin when functioning in the gun. This will cause a lightly struck cap resulting in a hang-fire and possibly a shot airscrew.

F. 60. Exchange the lock spring and test the weight.

F. 61. Gauge the protrusion of the firing pin with the gauge provided.

F. 62. Dismantle the lock and remove all burrs.

Extractor.

F. 63. Test the weight of the gib spring, it should be between 4 lb. and 5 lb. when the gib is flush with the extractor face. If not change the spring. Or—

F. 64. Engage the 0·058 gauge in the grooves and if it

is not held horizontally the gib spring must be exchanged.

F. 65. Ensure that the firing pin hole is not distorted or damaged through misuse of the cleaning rod.

F. 66. Examine for fractures.

Lock Frame.

F. 67. Examine for signs of fracture, the most probable points are at the apex of the right angle made by the underside of the stop, and the face of the lock frame on the sides of the frame behind the stop. Remove all burrs.

Firing Pin.

F. 68. Examine for fracture at the front end.

F. 69. Ensure that the point is not broken.

F. 70. Examine bent for wear.

F. 71. Examine the tumbler recess for channelling.

F. 72. Examine bents of trigger and tumbler for wear.

F. 73. Examine side levers, extractor levers, trigger tumblers and sear for fractures.

Miscellaneous.

F. 74. Make exchanges as necessary and reassemble.

F. 75. Weight and adjust the fusee spring. Exchange the spring if necessary.

F. 76. Check the weight of the recoiling portions.

F. 77. Test and adjust the length of the connection rod, (i.e., cartridge head space).

F. 78. Check the efficiency of feed and ejection as follows:—

(i) With the feed block fitted to the gun and the fusee spring removed, pull the recoil portion to the rear and watch the top lever to see if it clears the bridge of the feed block. For this test a few drill cartridges and links should be entered into the feed block.

(ii) Replace the fusee spring and feed a belt of drill cartridges into the feed block by drawing the recoil portions sharply to the rear and allowing the fusee spring to return the recoil portions to rest and to feed a round into position in the centre of the feed block and on the face of the extractor.

Ensure that the top pawls can be easily disengaged from the belt by pressure of the fingers on the pawls.

(iii) Make up a belt of drill cartridges and test by operating the loading handle and observing that feed and ejection take place smoothly.

F. 79. Test cocking gear as follows:—

(i) Scribe a line at right angles to the top edge of the side plate and vertically above the rear of the crank boss on the side plate.

(NOTE.—This is done by placing the base of a square on the top edge of the side plate with the blade downwards and against the rear of the boss.)

(ii) Scribe a second line 7/16 in. from the first, parallel to it and towards the muzzle of the gun.

(iii) Place the lock in position and adjust the fusee spring to between 4 and 5 lb. and release the trigger.

(iv) Slowly raise the crank handle until the nose of the trigger engages the tumbler bent, the click of which can be heard. Continue more slowly to raise the crank handle and stop when the click of the sear engaging the firing pin bent is heard. Great care must be taken to ensure that no further movement of the crank takes place after engagement of the sear.

(v) Hold the crank handle firmly in position at this point and examine the position of its rear edge in relation to the forward mark on the side plate. If it is in front, the lock so far as the firing pin, tumbler and sear are concerned, is in a serviceable condition. If the rear edge of the crank handle is in line with, or behind this mark, the lock should be returned to a depot for examination and repair.

F. 80. Treat all unserviceable parts with preservative and affix labels.

F. 81. Complete the gun history sheet.

SECTION 4.

LEWIS GUN.

INSTRUCTIONS FOR MAINTENANCE.

GROUP A.

Operations before Each Day's Flying when the Gun is to be Fired.

A. 1. Inspect the gun, its attachments and mounting for security and ensure that the gun and mounting have freedom of movement in all requisite directions.

A. 2. Check the correct functioning of the gun.

NOTE.—This is done by placing a few drill cartridges in a magazine, operating the cocking handle and trigger and observing that loading and ejection take place smoothly.

A. 3. Cock the gun and clean and dry the barrel using the cleaning rod and flannelette.

A. 4. Ensure that the flash eliminator is clean and secure.

A. 5. Clean and oil the moving parts and the working surfaces of the body.

A. 6. See that the magazine post extension is secure, that the setscrew is tight, and check the fitting of each magazine on the post to ensure that it will not come off in the air.

A. 7. Ensure that magazines have been tested and filled with S.A.A. and are secure on their mountings in the aeroplane.

A. 8. See that the spare part wallet is complete and correctly secured.

A 9. Check the sights of the gun for security and damage, and in the case of reflector sights for continuity of circuit.

A. 10. See that the deflector bag is secure.

A. 11. Test operation of gun heaters, if fitted.

GROUP B.

Operations at the Inspection between Flights if Firing is Taking Place during Flight.

B. 1. Ensure that the the gun is unloaded.

B. 2. Check the security of the gun, its attachments and mounting.

B. 3. Obtain the firer's report and if necessary make any exchanges.

B. 4. If any exchanges have been made check the correct functioning of the gun.

B. 5. Clean the barrel, using pull-through with gauze and flannelette, which must be pulled through six times.

B. 6. Exchange the gas regulator for a clean one.

B. 7. If time permits, remove piston rack assembly, clean gas cylinder by means of the cylinder rod with brush and mop, and re-oil.

B. 8. Ensure that the flash eliminator is secure.

B. 9. Empty deflector bags and containers and inspect for defects.

B. 10. Check the empty cases and remove any misfired rounds.

B. 11. Examine the sights for damage.

GROUP C.

Operations at the End of a Day's Flying if Firing has Taken Place.

C. 1. Ensure that the gun is unloaded.

C. 2. Remove the gun from the aeroplane as soon as possible after firing and take it to the armoury for cleaning.

C. 3. Strip the gun.

Barrel.

C. 4. Boil and dry.

C. 5. Inspect the bore for chemical corrosion and metallic fouling which, if present, must be removed.

C. 6. Try gauge plug ·303 and if this does not run repeat the de-nickelling process.

C. 7. Oil the bore and wipe the exterior of the barrel with an oily rag.

Trigger Group and Spade Grip.

C. 8. Those parts which are of wood or leather are to be cleaned by wiping with an oily rag.

Gas Regulator and Gas Chamber.

C. 9. Boil, dry and oil.

C. 10. If fouling remains after these parts have been cleaned it is to be removed by using a steel scraper, care being taken to avoid damage to the threads or the gas vent holes.

Gas Cylinder.

C. 11. Boil, dry and oil.

C. 12. If fouling remains after this has been cleaned it is to be removed by using the cleaning rod and brush provided, together with a little oil.

Breech Bolt and Piston Rod.

C. 13. Boil, dry and oil.

Pinion Casing Assembly.

C. 14. Wash in petrol, dry and oil.

General.

C. 15. Examine parts for damage and exchange if necessary.

C. 16. Remove all burrs.

C. 17. Any fouling which remains on other components is to be removed by means of a scratch card or No. 00 emery cloth.

C. 18. After cleaning, the various components are to be oiled and the external surfaces wiped with an oily rag.

C. 19. Enter day's firing, breakages and any exchange of parts in the gun history sheet.

GROUP D.

Operations at the End of a Day's Flying, when the Gun is Installed but has not been Fired.

D. 1. Ensure that the gun is unloaded.

D. 2. Check the security of the gun, its attachments and mounting.

D. 3. Clean the barrel, using cleaning rod and flannelette.

D. 4. If examination of the flannelette reveals the presence of rust, the gun must be taken to the armoury to be stripped and cleaned.

D. 5. Oil the barrel and the working parts and wipe the exposed parts of the gun with an oily rag.

D. 6. Ensure that the flash eliminator is secure.

GROUP E.

Operations at the 120 Hour Inspection of the Aeroplane when the Gun is Installed, but has not been Fired.

E. 1. Remove the gun from the aeroplane and take it to the armoury for cleaning.

E. 2. Check the correct functioning of the gun.

E. 3. Inspect the sights and ensure that they are clean and undamaged and in the case of reflector sights check for continuity of circuit.

GROUP F.

Operations after Firing 2,000 ± 500 Rounds.

F. 1. Ensure that the gun is unloaded.

F. 2. Remove the gun from the aeroplane and take it to the armoury for cleaning.

F. 3. Strip the gun for examination.

Barrel.

F. 4. Inspect for fractures, burrs, bulges and rust.

F. 5. Examine for chemical corrosion and metallic fouling. If present, fouling must be removed.

F. 6. Test the bore and chamber by gauge for wear, fouling and damage.

F. 7. View for straightness.

F. 8. Inspect the threads on muzzle and gas vent register for damage.

F. 9. If the barrel is found to be unserviceable, it must be exchanged.

Spade Grip.

F. 10. See that the milled headed screw is securely in place, that it has an oil brush attached and that the container is filled with clean oil. Exchange leather washer if necessary.

F. 11. See that the spade grip is easily detached from the body when the catch is clear. Remove all burrs.

F. 12. Check the distance between the body and the spade grip, first ensuring that the cover is fully forward. A 0·003 in. feeler should not enter; if it does, exchange the grip. If a 0·003 in. feeler still enters, the gun is unserviceable.

F. 13. Examine the lugs for fractures.

Trigger Group.

F. 14. Test the trigger group in the body for easy push fit. Remove all burrs.

F. 15. Remove the trigger and sear. Replace axis pins and lay trigger group on its side. If pins fall out, the holes in the trigger group should be tightened by lightly tapping around their edges with a small punch and hammer. The axis pin should be rejected if below 0·156 in. in diameter.

F. 16. Examine the plunger, its groove and spring for signs of damage and see that they are clean.

F. 17. Re-assemble the trigger and sear and check their correct functioning; the height of the sear should be 0·156 in. If necessary treat the inside of the trigger group frame, cam face of sear, and of claw edges of trigger with fine emery paper.

F. 18. Ensure that the butt catch will engage with the spade grip, exchange spring if necessary. Remove any burrs.

Pinion Casing Assembly.

F. 19. Test the pinion in the body for distortion and fit.

F. 20. Check the assembly by putting tension on the spring and rotating the pinion with the thumb. Release the pinion pawl when the pinion should rotate sufficiently to disengage the tension screw.

F. 21. Examine the teeth of the pinion for damage and remove burrs. If any teeth are broken the complete assemly is to be exchanged

F. 22. Examine the hub of the pinion for damage. Exchange the pinion pawl spring if necessary.

Bolt Assembly.

F. 23. Inspect the actuating stud for fractures; see that it is free and does not bind in its final movement. Remove burrs or score marks.

F. 24. Inspect the bolt for fracture. Examine the bolt cam-way for burrs and score marks which if present must be removed.

F. 25. Check the diameter of the bolt; the minimum diameter permissible is 0·897 in.

F. 26. Exchange the extractors after every 2,000 rounds and the extractor springs after every 4,000 rounds. The following instructions are to be complied with in making the exchange:—

(i) In stripping the extractor from the bolts, screwdrivers are not to be used as they are liable to cause burring of the bolt. A spring balance combination Mark II is the correct tool for the purpose.

(ii) Examine the extractor locating hole for elongation, if badly distorted the bolt assembly is to be exchanged. Slight elongation is to be adjusted by lightly tapping the front edge of the locating hole with punch and hammer, care being taken not to damage the cartridge face of the bolt.

(iii) The next extractor without spring is then to be placed in the bolt and pushed towards the bolt face. Proudness is to be corrected by stoning the front face of the extractor. The spring is then to be fitted and the extractor inserted in the bolt.

(iv) Test each spring; it should lift between 4 lb. and 6 lb. weight. If it fails in this test, it should be exchanged, irrespective of its life.

F. 27. Examine the firing pin hole for distortion, and burrs. If distortion is caused by the striker the piston rod assembly should be exchanged. Burrs should be removed.

Piston Rod Assembly.

F. 28. Examine for distortion, fracture, and fore-and-aft play.

F. 29. Test piston head for droop and sideway movement. Lay the piston and rack on its side on a flat surface. Place a steel rule near the head of the piston, push the head gently to the top of its movement and take a reading against the

steel rule. Now gently pull the piston head down to the bottom of its movement and read off the travel. If the piston head moves more than 0·375 in. the piston and rack are to be exchanged. Care must be taken to ensure that the rack does not move whilst the measurement is being taken. Test similarly with teeth downwards for sideway movement.

F. 30. Examine the head of the piston for wear; the minimum permissible diameter is 0·738 in.

F. 31. Measure the length of the rod by the gauge provided. It should not be less than 22·255 in. or more than 22·285 in. from the front of the striker post to the front face of the piston.

F. 32. Inspect the volute spring for tightness in the rack and for serviceability. The spring should protrude from the rear end of the rack by not less than 5/16 in. and not more than 7/16 in. The length of the spring should not be less than 1·072 in.

F. 33. Examine the striker for security and remove burrs from the striker post. If the cam face of the striker post is excessively worn through contact with the cam face of the bolt, the assembly should be exchanged.

F. 34. Check the protrusion of the striker with the gauge provided.

Body Assembly.

F. 35. Test the body for fractures. Fractures can usually be detected by ringing, that is by comparison of the duration and pitch of the note emitted when the bodies are suspended and struck by a light metal object. If cracks are suspected, detailed examination of the body should be made with a magnifying glass. If the body is cracked the gun is unserviceable.

F. 36. Examine the extension post for security. If ever the set screw is removed it should not be replaced but a new screw must be fitted.

F. 37. Test the body for wear, in the following manner:—

Take a standard 3·663 in. test bolt and a new barrel that has had about 50 rounds fired through it and which has therefore had the cartridge rim stop set down. Fit the body for

test to the barrel and place the test bolt on a piston rod assembly and insert the piston rod and bolt into the body. With the locking pin in, tap the body lightly near the locking piece, to ensure that it is screwed up hard against the pin. Insert the gauge 0·064 in. in the breech. Try the feeler gauges, starting with 0·002 in. feeler between the bolt and 0·064 in. gauge faces. If the bolt, with gentle pressure, closes over this, insert increasing sizes of feeler until one is found that the bolt will not close over. If it will not close over a 0·008 in. feeler, it is fit for further service.

F. 38. Examine the ejector for fracture and distortion and test for free movement; remove all burrs.

F. 39. Examine the ejector cover for correct seating or proudness.

F. 40. Examine the bolt way in the body and remove burrs.

F. 41. Examine the piston rod way for burrs, which, if present, must be removed.

F. 42. See that the pinion hinge pin is not bent and is securely fitted.

F. 43. Examine the body locking pin hole for distortion or damage.

F. 44. Examine the safety catches for fractures and test for correct operation.

Body Cover Assembly.

F. 45. Test the cover on the body; it should be capable of removal with slight assistance by hand; if too tight ease by use of a smooth file.

F. 46. Examine the cover for fractures and distortion. Remove all burrs.

Spade Grip (Mk. I, No. 1 Gun Only).

F. 65. Ensure that the securing screws are tight and the wood side-pieces in good condition.

F. 66. Set the safety catch to F and ensure that it is held firmly and clear of the trigger.

F. 67. Set the safety catch to S and ensure that it is brought into engagement with the lugs on the trigger and that it prevents any movement of the sear when the trigger is pressed.

F. 68. Failure in either F 66 or F 67 indicates a weak or broken spring or damaged part in which case te catch must be removed and the defect remedied or the defective part exchanged.

Trigger Guard Frame (Mk. I. No. 2 Gun Only).

F. 69. Examine the frame for dents, the wood grips for damage and security and the trigger bar guide pins for burrs.

F. 70. Exchange the pin of the trigger and trigger bar if loose.

F. 71. Ensure that the rods of the trigger bar are not distorted and that the distance pieces are not loose.

F. 72. Test the safety catch for efficiency and ensure that the studs on the spring plate will hold the catch in the fire or safe position.

Shoulder-piece (Mk. I, No. 2 Gun Only).

F. 73. Examine the shoulder-piece body for dents and the trigger bar guide pins for burrs.

F. 74. Examine the shoulder pad for security, ensure that all screws are tight and that the leather cover is not damaged.

F. 75. Ensure that the rods of the trigger bar are not distorted and that the distance piece is not loose.

Miscellaneous.

F. 76. Exchange damaged parts as necessary and reassemble.

F. 77. Fit a magazine loaded with good drill cartridges and operate the cocking handle and trigger. Ensure that loading and ejection take place smoothly.

F. 78. Treat all unserviceable parts with preservative and affix labels.

F. 79. Complete the gun history sheet.

SECTION 5.

GUN, VICKERS GAS OPERATION.

CHAPTER I.

INSTRUCTION FOR MAINTENANCE.

GROUP A.

Operations before Each Day's Flying when the Gun is to be Fired or Before Ground Firing.

A. 1. Inspect the gun, its attachments and mounting for security and in the case of the Mk. I, No. 2 gun, ensure that it has freedom of movement in all requisite directions.

A. 2. Ensure that the gas cylinder is free to move.

A. 3. Ensure that the flash eliminator and gas plug are screwed home and secured by their split pins.

A. 4. Ensure that the body extension securing pins are right home.

A. 5. Ensure that all split pins are in position and opened.

A. 6. Test the safety catch and magazine catches for efficiency.

A. 7. Check the correct funtioning of the gun.

NOTE.—This is done by fitting a magazine containing a few drill cartridges and operating the cocking handle and trigger and observing that loading and ejection take place smoothly.

A. 8. Cock the gun, set the safety catch to S and clean and dry the bore using the cleaning rod and flannelette.

A. 9. Clean and oil the moving parts and the working surfaces of the body.

A. 10. Check the sights for security and in the case of reflector sights for continuity of circuit.

A. 11. Ensure that the deflector bag is secure and free from damage.

A. 12. Ensure that the magazines have been inspected and filled with S.A.A., that magazine springs have the correct tension ($3\frac{1}{2}$ turns) and that the magazines are secure on their pegs in the aeroplane.

A. 13. See that the spare part wallet is complete and correctly secured.

GROUP B.

Operations at the Inspection between Flights, if Firing is Taking Place during Flight.

B. 1. Ensure that the magazine is removed.

B. 2. Empty the deflector bag and inspect for damage.

B. 3. Check the empty cases and remove any misfired rounds.

B. 4. Check the security of the gun, its attachments and mounting.

B. 5. Obtain firer's report and if necessary make any exchanges.

B. 6. If any changes have been made check the Para. A 7 correct functioning of the gun.

B. 7. Cock the gun, set the safety catch to S and clean the bore using the single pull-through with gauze and flannelette which must be pulled through six times.

B. 8. Clean the flash eliminator.

B. 9. Remove any foreign matter from the inside of the body and oil the working parts and surfaces.

B. 10. Examine the sights for damage.

GROUP C.

Operations at the End of a Day's Flying if Firing has Taken Place or at the Conclusion of Ground Firing.

C. 1. Ensure that the magazine is removed.

C. 2. Remove the gun from the aeroplane as soon as possible after firing and take it to the armoury for cleaning.

C. 3. Dismantle the gun with the exception of the body extension and spade grip. Chap. 1, para. 8-37.

Barrel.

C. 4. Boil and dry.

C. 5. Inspect the bore for chemical corrosion and metallic fouling which if present must be removed.

C. 6. Try gauge plug ·303 in. and if the gauge does not run, repeat the de-nickelling process.

C. 7. Oil the bore.

C. 8. Scrape the gas block, gas plug and flash eliminator to remove any fouling.

C. 9. Wipe the exterior with any oily rag.

Gas Cylinder and Piston Rod.

C. 10. Boil, dry and oil. The gas cylinder must then be cleaned with the rod and brush provided. The forward end of the cylinder must be kept clear of fouling; a tool is provided for this purpose. Fouling must be removed from the piston rod with scratch card or No. 00 emery cloth.

Breech Block.

C. 11. Wash in petrol and thoroughly oil. Fouling must be removed with scratch card or No. 00 emery cloth.

Body Extension.

C. 12. Wash in petrol and thoroughly oil. Wipe the exterior and the spade grip with an oily rag.

Body.

C. 13. Clean with any oily rag, dry and oil. Remove any fouling from the inside with scratch card or No. 00 emery cloth.

Generai.

C. 14. All parts of the gun not referred to above are to be cleaned with an oily rag.

C. 15. Examine parts for damage, remove all burrs and make exchanges as necessary.

C. 16. Enter day's firing, breakages and any exchange of parts in the gun history sheet.

GROUP D.

Operations at the End of the Day's Flying when the Gun is Installed but has not been Fired.

D. 1. Ensure that the magazine is removed.

D. 2. Check the security of the gun, its attachments and mounting and inspect for damage.

D. 3. Cock the gun, set safety catch to S. and clean the bore using cleaning rod and flannelette.

D. 4. Examine the flannelette and if the presence of rust is indicated, the gun must be taken to the armoury, stripped and cleaned. Group C.

D. 5. Oil the bore and the working parts and wipe the exposed parts with any oily rag.

END

GROUP E.

Operations at the 120 Hours Inspection of the Aeroplane when the Gun is Installed but has not been Fired.

E. 1. Remove the gun from the aeroplane and take it to the armoury for cleaning. Group C.

E. 2. Check the correct functioning of the gun. Paragraph A. 7.

E. 3. Inspect the sights and ensure that they are clean and undamaged and in the case of reflector sights check for continuity of circuit.

GROUP F.

Operations after Firing 2,500 500 Rounds.

F.1. If the rate of the gun has slowed down, examine for the following:—

(i) Broken buffer spring.

(ii) Broken return springs.

(iii) Wear on the piston head.

(iv) Wear in the guide.

F. 2. Ensure that the magazine is removed.

F. 3. Remove the gun from the aeroplane and take it to the armoury for cleaning. Group C.

F. 4. Dismantle the gun for examination. Chapter 1. Paragraphs 46-62.

Barrel.

F. 5. Inspect for fractures, burrs, bulges and rust.

F. 6. Examine the bore for chemical corrosion and metallic fouling, which if present must be removed.

F. 7. Examine the sight brackets and ensure that they are secure.

F. 8. Ensure that the gas block is not loose and remove all burrs from the spigot.

F. 9. Ensure that the gas plug port is not loose and that the channel in the plug is free of fouling.

F. 10. Test the front magazine catch for efficiency and if necessary exchange the spring. Ensure that the catch is properly secured by its split pin.

F. 11. Examine the collars at the rear for wear.

F. 12. Test the bore and chamber by gauge for wear, fouling and damage.

F. 13. View for straightness.

F. 14. If a barrel has fractures, bulges or fails to pass F. 12 or F. 13 above it is unserviceable.

Body.

F. 15. Ensure that the top and bottom piston stops are not loose.

F. 16. Examine for cracks in front of the locking shoulder.

F. 17. Test the rear magazine catch for efficiency and if necessary exchange the spring.

F. 18. Ensure that the locking shoulder is not loose.

F. 19. Ensure that the deflector bag catch brackets are secure.

F. 20. Examine the body extension securing pins for efficiency and if necessary exchange the springs and plungers.

Gas Cylinder.

F. 21. View for straightness.

F. 22. Remove all burrs.

F. 23. Ensure that the piston rod moves freely in the cylinder.

Barrel Strap.

F. 24. Remove all burrs.

F. 25. Examine for fit conjunction with the barrel and body. When these components are assembled there should be no longitudinal movement of the barrel.

F. 26. Ensure that the nut, bolt and split pin are in good condition.

Ejector.

F. 27. Examine for fractures.

F. 28. Remove all burrs.

F. 29. Tighten the rivets of the cover if necessary and ensure that the cover is a tight fit when in position.

Cocking Handle.

F. 30. Ensure that the catch is efficient and if necessary exchange the spring or catch.

F. 31. Examine the cocking lug for fractures.

F. 32. Test for freedom of movement in the body.

F. 33. Remove all burrs.

Breech Block.

Body.

F. 34. Remove all burrs.

F. 35. Examine for cracks at rear end of piston recess.

F. 36. Inspect firing pin hole for damage and the interior for score marks.

Extractor.

F. 37. Examine the claw for fractures.

F. 42. Change the spring if broken.

Firing Pin.

F. 43. Examine for fractures.

F. 44. Examine for score marks which if present will indicate friction against firing pin hole. Ensure that the pin is not bent.

F. 45. Ensure that the spring is efficient, i.e. that it will draw the pin inside the firing hole.

F. 46. Ensure that the retaining screw is not loose.

F. 47. Gauge the protrusion of the firing pin with the gauge provided. If it is excessive rub down the pin with the stone provided or with No. 00 emery cloth, taking care to preserve the radius; if it is insufficient, exchange the firing pin.

Piston Rod.

F. 48. Remove all burrs.

F. 49. Examine for fractures.

F. 50. Examine the bent for wear.

Return Springs Rod.

F. 51. Examine for straightness and remove all burrs.

Return Springs.

F. 52. Examine for fractures and exchange if necessary.

NOTE.—The springs will probably break before developing sufficient set to render them inefficient. Estimated life about 30,000 rounds.

Body Extension.

F. 53. Inspect for cracks near the holes for the securing pins.

Buffer Springs.

F. 54. Apply a steady hand pressure to the buffer and no movement should take place.

F. 55. Ensure that the buffer does not rotate.

F. 56. If there is any movement of the buffer a weak or broken spring is indicated, in which case the buffer must be stripped and the spring exchanged.

NOTE.—Estimated life of the spring is about 10,000 rounds.

Axis Pins.

F. 57. Examine for fit. If loose, the pins must be exchanged and the holes tightened if necessary by lightly tapping around the edges with a small punch and hammer, taking care not to distort the body extension.

Trigger Mechanism.

F. 58. Remove all burrs from the sear.

F. 59. Ensure that the sear axis pin is at the rear of its slot. If it is not, the sear buffer spring is probably weak or broken.

F. 60. Test the sear for freedom of longitudinal movement by applying pressure of the rear face of the sear; on releasing the pressure, the sear should return immediately to its normal position. If it does not do so, the sear lever or sear buffer spring may be faulty.

NOTE.—When carrying out the test, care must be exercised to ensure that the sear bent and the body extension are not damaged.

F. 61. Apply pressure to the trigger and ensure that:—

(i) The sear is drawn below the surface of the body extension. If it is not, a broken trigger rod, wear on trigger axis or wear between the trigger rod fork and the sear pin is indicated.

(ii) The sear catch engages the sear. If it does not, the lug on the sear, the projections on the sear catch or the sear catch or the sear catch spring is faulty.

F. 62. Release the trigger smartly and ensure that:—

(i) The trigger return immediately to its normal position. If it does not, a faulty trigger spring is indicated.

(ii) The sear rises. If it does not, a weak or broken sear spring is indicated.

F. 63. Press the trigger, release gradually and ensure that the sear does not rise until the trigger is almost against its stop. If the sear rises gradually with the movement of the trigger, it indicates that the sear catch is not functioning correctly.

F. 64. If any defect is indicated by F. 61, F. 62 or F. 63, the mechanism must be stripped and examined and the defect remedied or the defective part exchanged.

F. 47. See that the stop pawl axis pins are secure. If the pins are loose, the cover should be exchanged. Ensure that the stop pawls are moving freely on their axis pins. Examine for burrs and fractures. The pawls should protrude 0·15 in. from the front edge of the cover.

F. 48. Test the height of the tongue by using gauge No. 2677 as follows:—

Remove cartridge guide spring and feed arm assembly from the body. Fit body cover to the body and and insert the gauge between the body and the tongue on the body cover. If, when the gauge is in position, the incision in the gauge coincides with the hole in the tongue the height is correct. Adjustment of the tongue may be made by placing the body cover in the protected jaws of a vice and tapping the tongue (with a raw hide or similar hammer) to the set required. In the event of the tongue requiring resetting against a twist a correction should be made by fitting the jaws of a small shifting spanner on the root of the tongue and making the necessary amount of correction.

F. 49. The cartridge guide spring and spare springs, should be tested in conjunction with a magazine fitted with drill cartridges. The gun to be hand operated.

Feed Arm Assembly.

F. 50. Examine the feed arm for distortion, fracture and burrs, adjust as necessary.

F. 51. Test the latch rivet for security.

F. 52. Test the feed arm on the body for freedom of movement with a body cover and a magazine fitted. This should be done with the body cover in place.

F. 53. Test the feed arm on the magazine post; there should not be more than 0·02 in. fore and aft play.

F. 54. Examine the feed pawl stop for security and correct action. The pawl should protrude 0·15 in. when assembled to the body.

Swivel Distance Piece Assembly.

F. 55. Examine locating slot for burrs.

F. 56. Test the swivelling band for free movement and examine for cracks and see that the lugs are not compressed. The minimum inside dimension should be 1·417 in. of $^{27}/_{64}$ in.

Miscellaneous.

F. 57. Examine the stud of the gas regulator key and gas regulator for distortion.

F. 58. Check the fitting of the barrel band to the barrel; it must not be more than $^{3}/_{32}$ in. out of position.

F. 59. To test the gas chamber for fit place the barrel band on the barrel and screw the gas chamber into the barrel band. When screwed up the overturn should not exceed $^{1}/_{16}$ of a turn.

F. 60. Examine the gas cylinder for damage and fractures; when the cylinder is fitted to the chamber it must not overturn more than $\frac{1}{3}$ of a turn. If it does, providing there is sufficient length of cylinder, it may be adjusted by filing the cylinder face to give a complete turn.

F. 61. Examine the gas cylinder protector for distortion and fractures.

F. 62. Examine the cocking handle for fractures.

F. 63. Exchange damaged parts as necessary.

Adjustment to Return Spring.

F. 64. After the gun has been reassembled, check the tension on the return spring with the spring balance provided. This should be not less than 10 lb. and not more than 12 lb. After adjusting test for full cock, if it is impossible to cock, exchange the spring.

Efficiency of Feed and Ejection.

F. 65. Place a few drill cartridges in a magazine and test by operating the cocking handle and trigger and observing that loading and ejection take place smoothly.

F.66. Treat all unserviceable parts with preservative and affix labels.

F. 67. Complete the gun history sheet.

AIRCRAFT MACHINE GUNS—GENERAL CARE OF BARRELS AND REMOVAL OF OBSTRUCTIONS FROM THE BORE.

1. General Precautions.

(i) Regulation tools and materials only are to be used for the cleaning etc., of barrels.

(ii) The barrel, when removed from the gun for cleaning, etc., must be held securely in a vice of approved pattern, with copper clams.

(iii) The muzzle guide must be fitted to keep the cord contral, when the double pull-through is being used.

(iv) Oil and grease must be removed from the bore prior to firing.

(v) The bore must be examined, after using the cleaning rod or pull-through, to ensure that it is clear, as an obstruction, such as flannelette, is likely to cause a bulge which may damage the aeroplane or injure the firer.

(vi) Cross strain must not be applied to the cleaning rod as the bore may be damaged or the rod broken.

2. Tools and Materials for use on Machine Gun Barrels.

Pending the publication of a separate leaflet, Air Publication 1242, Part I, Chapter 8, paras. 20 and 21, 36 and 37, should be referred to for the necessary information.

3. Removal of a Broken or Jammed Pullthrough.

(i) Screw the tools bore plug on to the tools bore rod and place it in the barrel at the end nearest to the jammed flannelette.

(ii) Compress the flannelette as much as possible by pushing on the rod and withdraw the rod and plug.

(iii) Remove the plug and assemble the tools bore bushes and tools bore bits screw on to the rod and insert in the bore against the flannelette.

(iv) Turn the rod firmly in a clockwise direction, taking care not to turn the bit screw an excessive number of times as once the screw is full no further advantage is gained.

(v) Remove the assembly and clear the material from the bit screw.

(vi) Repeat the operation until the obstruction is completely cleared.

NOTE.—This operation should be done carefully and slowly by an experienced armourer.

ORDER No. I.

Aircraft Machine Gun.

Standard of System Maintenance.

1. This leaflet introduces a standard system of routine maintenance and partial overhaul for aircraft machine guns.

2. The work necessary falls into categories according to time intervals or number of rounds fired and is arranged under the following headings:—

A. Operations before each day's flying when the gun is to be fired.

B. Operations at the inspection between flights if firing is taking place during flight.

C. Operations at the end of the day's flying if firing has taken place.

D. Operations at the end of a day's flying when the gun is installed but has not been fired.

E. Operations at the 120 hour inspection of the aeroplane when the gun is installed but has not been fired.

F. Operations after the firing of a specified number of rounds.

G. Preparation and care of the gun when it is to be held in unit store in readiness for service.

3. These instructions are to be applied under all normal circumstances but may need amplification or amendment to meet local conditions or operational requirements. They do not absolve personnel concerned from the responsibility of acquainting themselves with or acting upon any circumstances indicating the necessity for additional work.

4. Maintenance operations to be done as follows:—

(i) A. B. D and E by flight personnel.

(ii) C and G by unskilled personnel under the supervision of an armourer.

(iii) F operations after the firing of a specified number of rounds are to be done by the armourer under the supervision of a fitter. armourer.

5. (i) The details of operations to be done under headings A, B, D and E will be reproduced in the maintenance schedules of aeroplanes as appropriate according to the types of machine guns fitted. Details of operations under G are given in A.P. 1641/2, para. 7.

(ii) Operations under A and E will be recorded in accordance with the instructions applying to the recording of the aeroplane maintenance on A.F. 700.

(iii) Operations under F must be recorded in the firing record of the gun history sheet. A N.C.O. fitter armourer is to sign the last column of the record. This entry is to follow any entries in respect of parts exchanged during those operations.

(iv) Operations under B, C, D and G need not be recorded.

6. It is important that a record is kept of the number of rounds fired by each gun. These figures are to be obtained from the ammunition state at between flight inspections and at the conclusion of firing.

7. The firer before leaving the cockpit or turret must attach to each gun a label which to be completed in accordane with the following instructions:—

(i) Synchronized gun or guns fitted in the cockpit which are loaded by the pilot. Record all stoppages.

(ii) Browning guns, turret installations. Record all stoppages and the number of rounds taken from the reserve.

(iii) Vickers class K and Lewis guns. Record all stoppages and the number of magazines fired by the gun.

(iv) In all cases the firer must also record on the label any other useful information as to the behaviour of the individual guns, which will enable the armourer to carry out maintenance to ensure that the guns are put into a serviceable condition or exchanged ready for the next flight.

8. The armourer must complete the label by entering up the number of the gun and the total number of rounds fired per gun.

9. In the case of plane installations the armourer must compile the label. After the guns have been unloaded he will record the number of rounds fired by each gun and make a note of any stoppages. The guns must be rendered serviceable or exchanged ready for the next flight.

10. The information on the labels will be used for completing the gun history sheets at the end of the day's firing.

11. When a defective gun is removed from an aeroplane, it must be labelled to show the reason for its removal before it is returned to the armoury for overhaul.

12. The operations due after the specified number of rounds may be anticipated or delayed by 500 rounds at the discretion of the armament officer or squadron armament instructor. Wherever possible these operations are to be applied immediately prior to any likely periods of concentrated firing e.g. attachment to armament training stations.

13. Any groups or components of machine guns found unserviceable are to be cleaned and treated with preservative, labelled to show the cause of unserviceability and the life of the part in rounds and returned to the appropriate maintenance unit, at regular intervals. The preservative to be used will be a mixture of equal parts by weight of red mineral jelly and lubricating oil. Thick coatings should not be applied and in cold weather the mixture should be warmed to enable a thin coat to be applied. This does not apply to parts for which a definite life is laid down which are to be broken when withdrawn from use.

14. Mechanical failures of the gun, defects and damage are to be reported by the operator of the gun or armament personnel concerned to the armament officer or squadron instructor who is to decide whether the gun is to be replaced and is to arrange for repair work as necessary. Entries in gun history sheets and other records are to be made accordingly. Attention is drawn to A.P. 1242/Z.4.

AIRCRAFT MACHINE GUNS.

MAINTENANCE.

1. General instructions to be observed in the care and cleaning of machine guns. The detail maintenance inspections and operations outlined in the instructions for maintenance and repair of the gun, i.e. Vol. II. Part 3, of the gun handbook, and in the oppropriate aeroplane maintenance schedule should be applied in conjunction with these general instructions and information.

2. *General Care and Cleaning.*—(1) (*a*) To avoid damage to the various parts, great care must be exercised in the daily handling and cleaning of machine guns.

(*b*) Cleaning and lubrication are of the greatest importance so that the gun may efficiently undertake any task demanded of it from a mechanical point of view, this applies particularly to the recoiling portions and the working surfaces to keep friction as low as possible.

(*c*) No oil other than that provided for the purpose, is to be used for lubricating the gun and its mechanism. To ensure that the bore will be properly oiled, it is necessary to dip the flannelette, 4 in. by 2 in., into the oil and allow to soak; if the oil is poured on to the flannelette it is liable to be scraped off by the end of the barrel.

(ii) (*a*) Paraffin must not be used for cleaning machine guns. Rust must be removed in accordance with paragraph 4 of this leaflet.

(*b*) After firing, the barrel and all parts of the gun that have been affected by gas, must be steeped in boiling soda water, ½ lb. of soda to 1 gallon of water for 5 minutes, and then in clean boiling water which should be frequently changed for a further period. The part must then be dried and oiled. Loaded springs, however, must not be boiled.

(*c*) Ordinarily, dirt can be removed with an oily rag, but in obstinate cases boiling as above will be necessary.

(*d*) If soda and boiling water are not available, petrol may be used, see A.P. 1464/C.14.

(iii) (*a*) When the bores of guns are cleaned *in situ*, with the cleaning rod and flannelette, 4 in. by 2 in., it is essential that the breech be opened and a piece of metal tubing fitted to the rod to prevent the point of the rod from hitting and damaging the firing pin hole.

(*b*) At inspections between flights, the bore must be cleaned with the single pull-through, gauze, 2½ in. by 2½ in., and flannelette, 4 in. by 2 in. A piece of stiff wire is provided to enable the pull-through to be drawn through the bore.

(iv) Burrs must always be removed with the stone provided for the purpose, care being taken not to remove more of the adjacent metal than is absolutely necessary. Stoning should be done only by fitters, armourer.

(v) (*a*) For stripping and assembling the authorised tools must be used.

(*b*) Damaged parts must be exchanged without delay.

(*c*) The gun must not be lifted or carried by the barrel or barrel casing; neither is it to be used as a lever for moving the turret when so mounted, or for testing the rigidity of the mounting.

(*d*) When the gun is unloaded the main spring and firing pin spring must be eased when possible by closing the breech and releasing the firing pin.

3. *Barrels.*—(i) The life of a barrel varies according to the rate of fire and the care exercised in cleaning. The chief defects are wear and fouling, and, in order that instructions for cleaning may be understood it is necessary that the cause of these defects should be realised.

(ii) Wear is due to:—

(*a*) Friction of the bullet.

(*b*) Erosion of the bore by the rush of hot gases.

(*c*) Friction of the pull-through gauze when the bore is being cleaned. Undue wear is caused by the improper and unnecessary use of gauze. To prevent this it is most important that the instructions for cleaning are observed. High polish of the bore is a safeguard against rust. When new the bore

has a high polish but as it becomes worn this polish diminishes and the use of gauze to restore it results in unnecessary wear and should be discouraged.

(iii) *Fouling is of Three Kinds*:—

(*a*) Chemical corrosion caused by the forcing of the products of combustion into the pores of the metal, which can be detected by a dark colouration of the polished surface.

(*b*) Powder fouling, caused by the deposit in the bore of the solid products of combustion, and giving the bore a dirty appearance.

(*c*) Metallic, caused by a portion of the cupro-nickel envelope of the bullet being left on the surface of the bore and appearing as a whitish streak on the lands or as a roughness on the edge of the grooves, visible to the eye at the breach and muzzle.

4. *Removal of Fouling*:—

(i) Chemical corrosion and powder fouling are hardly likely to develop if the bore is cleaned in accordance with paragraph 1 (ii) (*b*) immediately after firing. If corrosion is not removed by washing, 30 to 40 strands of hard brass wire No. 26, s.w.g. well soaked in lubrication oil should be used in the cleaning rod and pushed up and down the bore, after which the bore must be washed with boiling water, dried and oiled. Every endeavour must be made by cleaning after firing, to prevent corrosion as its removal by the use of wire is a cause of unnecessary wear. Neglect leads to the formation of rust, as the fouling becomes hard and absorbs moisture from the air.

(ii) Metallic fouling can be removed by one of the following methods. The barrel must be carefully watched, as metallic fouling is a cause of inaccuracy and, if excessive, may lead to a bulge or burst barrel.

(*a*) Dissolve two tablets K.N. in 40 cc. of liquid ammonia, which is enough to fill one barrel, of 0·950 s.g. Plug up the barrel, fill with the solution and allow

to stand for 30 minutes. If nickel is present the solution will turn a dark greenish blue and the treatment should be continued until the solution remains clear. The bore must then be washed with boiling water, dried and oiled.

(*b*) Assemble a piece of wire gauze, 2½ in., in the loop of the double pull-through so as to form two cylinders. The gauze should fit the bore tightly. Grit must be removed from the pull-through and gauze and they should be thoroughly oiled. The barrel is to be held steady and a muzzle guide must be fitted to keep the pull-through central. The cord should then be pulled backwards and forwards, with the gauze about the position of the nickelling, until the fouling is removed. The bore must then be washed with boiling water, dried and oiled.

5. *Rust.*—(i) Rust must be removed from the various parts of the mechanism by using No. 00 emery cloth or scratch card, after which the part must be washed with boiling water, dried and oiled.

(ii) To remove rust from the bore use 30 to 40 strands of hard brass wire No. 26, s.w.g. in the cleaning rod as for the removal of chemical corrosion or use double pull-through and wire gauze as in the case of metallic fouling.

(iii) Once a barrel has become rusty it will always be more liable to rust than one which has been kept free and in good condition. A barrel showing signs of wear will require more care than one in which the surface has not been attacked. Coating the bore with a film of oil prevents moisture from attacking the metal and forming rust.

6. *Unauthorised Modifications.*—No unauthorised modification is to be made to machine guns, their attachments or mechanisms. Attention is drawn to K.R. and A.C.I., para. 72 (5).

7. Preparation and care of the gun when it is to be held in unit store in readiness for service.

(i) Strip the gun.

(ii) Thoroughly clean all the components.

(iii) Examine for burrs which must be removed.

(iv) Oil and reassemble the gun.

(v) Label with the number of the aeroplane and gun position and store in the gun cupboard or box, which must also have a label attached.

(vi) At least once a month the major components are to be removed, cleaned free of oil and examined for rust which, if present must be removed.

(vii) The components must then be oiled and re-assembled and the gun returned labelled to its cupboard or box.

APPENDIX I.

INSTRUCTIONS FOR THE MAINTENANCE OF THE MK. I VICKERS' MAGAZINE.

OPERATIONS AFTER THE MAGAZINE HAS BEEN REPAIRED.

VISUAL EXAMINATION.

Magazine Body.

1. Ensure that the cartridge head guide ring if free from dents and burrs and that it is held securely.

2. Examine the welding at the ends of the guide ring and at the junction of the guide ring with the cartridge guide and ensure that it is not cracked.

3. Ensure that the cartridge guide is not cracked.

4 Ensure that the bullet guide is secure and free from damage.

5. Ensure that the stop stud for the platform is secure.

6. Ensure that the catch plates and spring clips are free from cracks and burrs.

7. Ensure that the flange and plate are efficiently soldered to the band. Test by applying steady finger pressure against the flange or plate and observing whether any movement takes place.

8. Ensure that the solder has not run particularly at the front magazine catch plate.

9. Remove all burrs and surplus solder.

10. Ensure that all rivets are tight.

Top Plate.

11. Ensure that the separators are secure and free from damage.

12. Examine the separators and if any are not perpendicular they must be straigtened with a pair of pliers.

13. Examine the rim for dents and burrs which if present must be removed.

14. Ensure that the main spring is secure on its anchorage in the spring casing.

15. Remove all burrs.

16. Ensure that all rivets are tight.

Bullet Support with Platform and Spring.

17. Ensure that the bullet support and platform are free from cracks and that the rivets are tight.

18. Ensure that the spring is not loose on the bullet support, tighten if necessary.

Handle with Bush.

19. Ensure that the handle and bush are free from cracks.

20. Ensure that the hook-shaped projection and the outsides of the retaining pin slot are free from damage.

21. Ensure that the leather handle is secure and free from damage.

Gauging the Magazine.

Magazine Body.

22. Place a good drill cartridge near the edge of the slot and test to see if it will rock. If it does, proudness of the lip or a concave plate is indicated.

23. Enter the 0·52 in. gauge in the lips from the inside with the flats towards the lips and push it against the band. Turn the gauge until the convex surfaces bear on the lips and pull it towards the inside. The gauge must not pass the middle rivet of the cartridge guide. If it does, the lips must be closed by tapping with a hammer. To remove the gauge, put it towards the band, turn and withdraw if from the inside.

24. Enter the 0·513 in. gauge in the lips from the inside and push towards the band. It should be a good fit. If the gauge is tight, lift the cartridge guide with the tool provided or lift the lip with a drill cartridge.

25. Pass the 0·54 in. gauge around the inside of the body from the cartridge guide to the platform stop keeping it pressed against the band. If the gauge sticks, examine the cartridge head guide ring or flange at the point for question for dents. To remove dents from the guide ring use the tool provided. To remove dents from the flange place the steel block provided above and below the guide ring and tap the flange lightly with a hammer.

26. Place the special gauge against the magazine body and test the height of the lips and bullet head and the dish of the plate with feeler gauges. The maximum limit is 0·01 in.

27. Place the concentricity gauge over the spigot within the arm under the cartridge head guide ring and against the cartridge guide. Rotate the gauge until the incline of the guide ring is reached then lift the centre portion as the arm travels up the incline and, keeping it supported and held squarely, continue the rotation until the platform stop is reached. The gauge must run without undue friction. If it does not, remove it and ensure that the spigot is perpendicular, and examine the band for dents which must be removed.

28. Place the magazine body on the body gauge and ensure that the dummy catches will just pass over the catch plates. Hold the magazine and ensure that the plug passes freely between the lips. Ensure that the bullet lead does not foul the recess in the gauge.

29. Test the width of the gap between the bottom of the lips with the gauge provided. The 0·35 in. end of the gauge must go the 0·37 in. end must not enter more than $\frac{1}{4}$ in. from the outside and must not go from the inside.

30. Assemble a round in the lips from the underside with the bullet resting on the bullet lead and examine to see if the point of the bullet is in line with the edge of the boss of the spigot. If it is not, the lips must be corrected for alignment.

31. Pass a 0·54 in. dummy round into the lips from the inside and ensure that it enters freely.

Top Plate.

32. Place the top plate on the gauge provided and test the contour of the surface. The plate should not rock and the maximum space between the plate and the gauge, both around the edge and in the middle, must not exceed 0·003 in.

33. Gauge the height and angle of the separators with the gauge provided. Reject if the clearance is more than 0·01 in.

34. Gauge each space with the platform which must enter freely.

Bullet Support with Platform and Spring.

35. Gauge the angle of the platform with the gauge provided. Reject if the clearance is more than 0·005 in.

36. Gauge the length of the platform with the gauge provided. Reject if the clearance is more than 0·015 in. or if the clearance between the bullet support and the boss on the gauge is more than 0·005 in.

Miscellaneous.

37. Assemble the magazine. Chapter 1, paragraph 75.

38. Ensure that the spring clips hold the top plate in position.

39. Ensure that the top plate will rotate freely on the body.

40. Ensure that the bush will engage and hold the main spring.

Operations before the Magazine is Loaded.

41. Dismantle the magazine and ensure that it is clean and dry. Chapter 1, paragraph 72-74, paragraph 1-21.

42. Visually examine the magazine.

43. Pass a good drill cartridge around the inside of the magazine body from the cartridge guide to the platform stop, keeping the base of the case pressed against the band. If the cartridge sticks examine the cartridge head guide ring and flange for burrs or dents which if present must be removed.

44. Pass a good drill cartridge into the lips from the inside and remove it from the magazine by pressing against the base of the case. If there is any undue friction the magazine must be put aside for further examination.

45. Gauge the spaces on the top plate with the platform which must enter freely.

46. Ensure that all separators are perpendicular, adjust if necessary using a pair of pliers.

47. Miscellaneous. Paragraph 37-40.

General Care and Cleaning.

48. After firing unload the magazine and release the spring tension.

49. Dismantle the magazine and clean it with an oily rag. Chapter 1, paragraph 72-74. A.P. 1641/2 paragraph 2 (ii) (*b*).

50. Examine the magazine body for fouling near the slot. If fouling is present the magazine body must be boiled and dried.

51. If stoppages have occurred due to magazine failures, the defective magazine must be put aside for gauging and examination.

52. Reassemble the magazine and store it in the rack provided. Chapter 1, paragraph 75.

53. When not in general use magazines are to be dismantled once a month and examined for corrosion, cleaned and replaced in the rack.

APPENDIX I.

INSTRUCTIONS FOR THE MAINTENANCE OF LEWIS GUN MAGAZINES.

Operations to be Carried out after the Magazine has been repaired.

1. Visually examine the magazine and ensure that:—
   (i) There are no dents or fractures in the serrations on the periphery of the pan.
   (ii) All burrs and sharp edges have been removed.
   (iii) All rivets are tight and that the height of the bottom rivets does not exceed 0·02 in.
   (iv) The struts and pegs are tight.
   (v) All the plates are central.
   (vi) The centre block is free from damage, not corroding, and that the nuts are tight.
   (vii) The handle is secure and the strap serviceable.
   (viii) The catch is assembled correctly and works freely.

2. (i) Place the magazine on a dummy body (which has had the rebound pawl filed away) and turn it until the feather-way comes opposite to the feather on the magazine post. Press lightly on the top of the magazine and if it does not seat easily fouling of the stop pawl is indicated.

(ii) Lift the magazine without releasing the catch and if the magazine can be removed a faulty catch is indicated.

3. Gauge each cartridge head recess with the gauge provided. The gauge must pass freely to the bottom of the recess.

4. Gauge the distance between the pegs with the gauge provided and ensure that it is within the limits.

5. Straighten the pegs if necessary with the tool provided and repeat the test.

6. Test the position of the pegs relative to the centre block and to the periphery of the magazine with the magazine tester.

7. Test the alignment of the pegs and cartridge head recesses with the special dummy gauge.

8. Place a drill cartridge in position in the magazine, disengage the catch and slowly rotate the pan until the drill cartridge reaches the end of the groove. The cartridge should travel freely and without the application of undue pressure on the pan. Rotate the pan slowly in the opposite direction to remove the drill cartridge. If any opposition is felt when the magazine is rotated it indicates that the groove in the centre block is burred or damaged or that the heads of the securing bolts are proud.

9. Place the drill cartridge in position in the magazine, disengage the catch and spin the pan. The drill cartridge should be carried to the end of the groove. Spin the pan in the opposite direction and the round should be thrown clear of the magazine. Failure indicates friction between the centre block and the pan.

10. Apply the reject gauge to the centre hole. If the gauge enters, the magazine is unserviceable.

11. Place the magazine on the special plate gauge and test the pan for concentricity. See that the magazine does not foul the plate at the bottom edge.

Operations to be carried out before the Magazine is Loaded.

12. Visually examine the magazine.

13. Place the magazine in position on a gun and engage the catch. Lift the magazine without releasing the catch and if the magazine can be removed the catch is faulty and the magazine must be put aside for further examination and repair.

14. Rotate the magazine to see that no part of the lower circumference touches the rearsight bracket or body cover.

15. Test the position of the pegs relative to the centre block and the periphery with the magazine tester.

16. Test for freedom of movement using a good drill cartridge.

17. Ensure that the inside of the pan and the groove in the centre block are free from oil.

General Care and Cleaning.

18. Magazines must be kept clean and handled with care or stoppages will occur.

19. Dirt and dried oil must be removed with an oily rag but care must be taken to dry the pan and centre block.

20. Test for freedom of movement after cleaning by placing the magazine on the loading handle and revolving the pan. Sluggishness indicates dirt in the junction between the centre block and the pan.

21. Ligthly oil the frictional parts after cleaning.

22. When in store magazines must never be stored more than two deep and the leather handle must be folded between the brackets.

SECTION 1.

BOMB CARRIERS.

INSTRUCTIONS REGARDING ARMAMENT MAINTENANCE SCHEDULES.

BOMBING EQUIPMENT.

1. Inspection of Electro-Magnetic Bomb Carriers.

Inspection of armament equipment will be carried out by armourers in accordance with the inspection schedules attached hereto. The schedules are divided into the following groups:—

"*A*"—*Fitted Armament.*

1. Daily Inspections.
2. Weekly Inspections.
3. Monthly Inspections.
4. Quarterly Inspections.

"*B*"—*Stores Armament.*

1. Quarterly Inspection.

In order that the weekly inspections may be made to coincide with the airframe and engine periodic inspections, whenever possible, the inspection may be carried out at any time between the 5th and 9th day following the preceding weekly inspections. The monthly inspection may be carried out at any time between the 25th and 35th days following the preceding monthly inspection; and the quarterly inspection may be carried out at any time between the 10th and 14th week for the same reason.

NOTE.—The following defines the classification "Fitted Armament" and "Stored Armament":—

Fitted Armament includes all armament equipment which, under normal conditions, is permanently kept fitted to aircraft.

Stored Armament includes all armament equipment held on charge which is not normally kept permanently fitted to aircraft.

2. Records of Inspections, Modifications, etc.

(i) *Form* 700.

A. *Daily Inspections*:—

(i) The record of daily inspections of equipment fitted to aircraft will be recorded by the armourer's signature in column 20 of the front page of the Form.

(ii) Flight armament N.C.O.'s will carry out a daily check inspection of a complete assembly group at periods during each month. The assembly groups will be selected in such a manner that, at the end of each month each item of armament equipment will have received a daily check inspection. On the completion of the inspection, N.C.O.'s will sign the Form 700, in column 33, against the group inspected, together with the date.

B. *Weekly Inspections*:—

(i) Flight armourers will enter, in the place provided on Form 700, the record of weekly inspections, with their signatures.

(ii) Flight armament N.C.O.'s will select assembly groups and carry out a weekly check inspection. The selection of these groups must be so arranged that, at the end of each month, every item of armament equipment will have received a weekly check inspection. On completion of the inspection, Flight armament N.C.O.'s will enter on Form 700, the group, together with his signature and the date.

C. *Quarterly Inspections*:—

(i) Flight armourers will enter on Form 700, in the place provided for weekly inspections, the records of quarterly inspections, with their signatures.

(ii) The Squadron armament N.C.O. will carry out a complete check of an assembly group when the quarterly inspection has been completed. He will record the inspection of the group, together with his signature and the date, against the entry of the quarterly inspection by the Flight armourer.

(ii) *Armament Logbooks.*—All Flights will open and maintain logbooks under the heading "Bombing Equipment", and the logbooks will contain the following detail:—

(*a*) Allocation of equipment.

(*b*) Record of mechanical defects.

(*c*) Record of all inspections carried out.

To ensure that correct supervision and check is carried out, the Warrant Officer or Flight armament N.C.O. will be personally responsible for the compilation of these records. The logbooks will be checked and initialled monthly by the Flight Commander.

(iii) *Armament Modification Chart.*—A chart will be maintained in the Flight armoury, showing:—

1. Date leaflet received.
2. Modification number.
3. Logbook number.
4. Leaflet number.

5. Class.
6. Allotted to aircraft No. (equipment).

A code, as under, will be used, showing the true state of the armament equipment held on charge:—

"1" Spares on demand.
"2" Spares not available.
"3" Spares received.
"4" Modification incorporated.
"5" Permission not to incorporate applied for.

ARMAMENT MAINTENANCE ORDERS.

Monthly Inspection—Light Series Carriers.

The carrier is to be removed from the aircraft, thoroughly cleaned, and handed to the Flight W.O.M. for the removal, inspection and replacement of the release units.

Monthly Inspection—Universal Carriers.

As for Light Series Carriers

Quarterly Inspections.

All stored carriers will be fitted and tested in accordance with K.Rs. and A.C.Is., para. 773.

ARMAMENT MAINTENANCE ORDERS.

INSPECTION OF BOMB CARRIERS, LIGHT SERIES, TYPE E.M., *AND* BOMB CARRIERS, UNIVERSAL. TYPE E.M./M.F.

General.

1. In view of the fact that Light Series carriers are on the Flight and not on the aircraft inventory, and may therefore be fitted to any aircraft, a Flight serial number is to be painted on each carrier. Whilst the carrier will be retained on the same aircraft as far as practicable, this number will be quoted, in brackets, when any entry of any inspection, other than daily, is made either on Form 700 or in the armament logbook.

2. Armourers will ensure that the Wireless Operator Mechanics have signed Form 700 to the effect that the electrical inspections have been completed, before carrying out the following instructions:

Daily Inspections—Light Series Carriers. Type E.M.

LS. 1. Inspect the carrier for security and general cleanliness.

LS. 2. Ensure that all parts (other than the release unit) are serviceable. Armourers are not responsible for the serviceability of the release unit.

LS. 3. *Lubrication.*—The following parts are to be kept lubricated with the standard bomb carrier lubricant:

(*a*) The felt pads on each side of the suspension hook.

(*b*) The loading latch.

(*c*) The spring loaded nose and tail steadies.

LS. 4. Load the carriers for test with dummy bombs, as follows:—

1. Place the spring loaded steadies in their highest positions and secure with the clamping screws.
2. Cock all releases by pulling downwards on the trigger. The movement of the trigger must be carried out sharply, and pressure applied and released two or three times to ensure that the release lever has become engaged with the trigger.
3. Press down on the plunger, on the top of the release unit, to ensure that the main and safety armature levers are fully engaged.
4. Engage the bomb suspension lug with the suspension hook of the release unit; pull downwards on the centre of the bomb to ensure that it is fully engaged with the release slip.
5. Loosen the clamping screws on the steadies, and allow the steadies to come into contact with the bomb. Adjust the bomb to the correct position, and securely clamp the steadies.
6. Switch on the master switch.
7. Press down the selector switches in turn and operate the firing switch for all bombs carried. When any selector switch is put down, the lamp should be illuminated, and when the firing switch is operated, the lamp should go out and the bomb fall.
8. When the tests have been made and give the results indicated, switch off the master switch and place the selector switches in the "Up" position.

Daily Inspections—Carriers, Universal. Type E.M./M.F.

UC. 1. Examine the carriers and stays for security.

UC. 2. See that the carrier is clean and the release slip lubricated.

UC. 3. Examine the fuzing cable for fraying and easy running.

UC. 4. Examine the steadies and adjusting screws for freedom of movement.

NOTE.—All functional tests will be carried out by the Flight W.O.M. in accordance with WT. 6.—"Maintenance Schedule for E.M. Release Electrical System."

Weekly Inspection—L.S. Carriers.

LS. 11. The framework of the carrier is to be thoroughly cleaned and left dry.

LS. 12. The G.S. oil and graphite lubricant is to be completely removed from the nose and tail steadies, and replaced by a fresh mixture.

Weekly Inspection—Universal Carriers.

UC. 11. The carrier is to be thoroughly cleaned.

UC. 12. Examine the stays for firmness and security, Special attention being paid to any signs of distortion of the alignment of the carrier.

UC. 13. Examine the fuze and lever and ensure that it engages each notch on the quadrant.

UC. 14. Examine the fuzing tube for ease of movement, particularly towards the end of its travel.

UC. 15. Clean the fuzing cable.

NOTE.—Care is to be taken to ensure that no cleaning medium, such as paraffin, is allowed to enter the release units or terminal blocks. The leads are to be kept in a dry condition.

SECTION 2.

BOMB RELEASE SYSTEMS.

MAINTENANCE ORDERS FOR THE INSPECTION OF ELECTRIC-MAGNETO BOMB RELEASE ELECTRIC SYSTEM.

1. The inspection of the electrical system will be carried out by Wireless Operator Mechanics in accordance with the following schedules. The schedules are divided as under:—

(*a*) Daily Inspection.
(*b*) Weekly Inspection.
(*c*) Monthly Inspection.
(*d*) Quarterly Inspection.

In order that the weekly inspections may be made to coincide whenever possible with the airframe and engine periodic inspections, the inspection may be carried out at any time between the 5th and 9th day following the preceding weekly inspection. The monthly inspection may be carried out at any time between the 25th and 35th days following the preceding monthly inspection. and the quarterly inspection may be carried out at any time between the 10th and 14th week following the preceding quarterly inspection, for the same reasons.

2. *Records of Inspections, Modifications, etc.*

(i) *Form* 700.

A. *Daily Inspections.*

(i) The record of daily inspections of equipment fitted to aircraft will be recorded by the armourer's signature in column 20 of the front page of the Form.

(ii) Flight armament N.C.O.'s will carry out a daily check inspection of a complete assembly group at periods during each month. The assembly groups will be selected in such a manner that at the end of each month, each item of equipment will have received a daily check inspection. On the completion of the inspection, N.C.O.'s will sign the Form 700, in column 33, against the group inspected, together with the date.

B. *Weekly Intspections.*

(i) Flight armourers will enter, in the place provided on Form 700, the record of weekly inspections with their signatures.

(ii) Flight armament N.C.O.'s will select assembly groups and carry out a weekly check inspection. The selection of these groups must be so arranged that, at the end of each month every item of armament equipment will have received a weekly check inspection. On completion of the inspections, Flight armament N.C.O.'s will enter on Form 700 the group inspected, their signatures, and the date.

C. *Quarterly Inspections.*

(i) Flight armourers will enter on Form 700 in the place provided for weekly inspections, the record of quarterly inspections, with their signatures.

(ii) The Squadron armament N.C.O. will carry out a complete check of an assembly group when the quarterly inspection has been completed. He will record the inspection of the group, together with his signature and the date, against the entry of the quarterly inspection by the Flight armourer.

(ii) *Inspection Record Book.*—All Flights will open and maintain books containing the following details:—

(a) Record of defects.
(*b*) Record of all weekly, monthly and quarterly inspections carried out.
(*c*) Record of all inspections to release units.

To ensure that correct supervision and check is maintained, the N.C.O. Wireless Operator Mechanic or senior W.O.M., in each Flight will be personally responsible for the compilation of these records. The book will be checked and initialled monthly by the Flight Commander.

Daily Inspections.

WT. 1. Test voltage of the accumulator on load. Examine accumulator and ensure acid level is correct, and that all traces of acid are removed from the case.

WT. 2. Instal the accumulator in the aircraft.

WT. 3. Examine the 2-pin firing switch plug. Ensure that the plug is firmly home and the clip in position.

W.T. 4. Examine the fuse.

WT. 5. When the distributor is to be used, examine the segments of the auto-distributor box and test each circuit by means of the moving arm (switch to be in the " test " position).

WT. 6. Test each release unit separately to operate on 8 volts from the external 5-pin plugs.

WT. 7. (i) Put all plugs in their appropriate sockets and ensure that they are firmly home. Connect the feed cable to the source of supply and put on the master switch.

(ii) Place all selector switches in the " up " position and cock all releases. The indicating lamp should not be illuminated.

(iii) Select each release in turn and operate the firing switch. The indicating lamp should be illuminated when the selector switch is put down and should go out when the firing switch is operated. Each release unit should of an " earth " during these tests.

(iv) When these tests have been correctly carried out, switch off the master switch.

WT. 8. All jettison lamps are to be carefuly inspected for looseness in their sockets, and for possible fracture of the sealing compound between the lamp cap and the glass bulb. Looseness between the lamp cap and bulb may cause a short circuit on closing the selector switches.

NOTE.—*Accumulators*: Accumulators are to be drawn as required from Signal Section. On completion of the day's flying the accumulators are to be given a voltmeter test on load,

and if found to be down to 2 volts, they are to be taken to the Station Signal Section for charging and weekly, they are to be given a " topping-up " charge. The airman drawing the accumulators from the Signal Section is to ensure that they are in good condition, clean and free from leaks. The accumulators are to be tested by voltmeter and hydrometer tests, the acid is to be brought to the correct level.

Weekly Inspection.

WT. 11. Examine the following plugs and ensure that the pins are clean. Test the width of the saw-cut in each pin. Width should be 20/1,000 inch for 5-pin plugs, and 13/1,000 inch for 3-pin plugs:—

Two 3-way plugs.
Six 5-pin plugs.
Six 2-pin plugs.

WT. 12. Examine master switch and ensure contacts are clean.

WT. 13. Remove fuze and examine contacts.

WT. 14. Examine the following terminal blocks and tighten screws:

Two 5-way.
Two 2-way.
One 3-way.

Monthly Inspection.

WT. 20. Remove release units from carriers.

WT. 21. Examine electrical contacts.

WT. 22. Examine all bearings and remove causes of friction, if necessary. The following are the most important points:—

(*a*) Pivots for trigger, main and safety armature levers.

(*b*) Bearing surfaces between main and armature lever and trigger.

(*c*) Bearing surfaces between trigger and cocking lever.

(*d*) Bearing surfaces between main and safety armature levers (friction in this instance is the most likely cause of a " half-cock ").

WT. 23. Examine internal wiring, ensure that the leads do not impede the working of any moving parts.

WT. 24. Examine the return springs on both armatures, and test for freedom of movement.

WT. 25. Examine trigger springs.

WT. 26. Check clearance between main armature lever and trigger, this should be between 6,000th inch and 10,000th inch.

WT. 27. Check clearance between main and safety armature levers, this should be between 6,000th inch and 10,000th inch.

WT. 28. Dismantle the selector switch boxes and examine all contacts including the pins connecting the boxes.

Quarterly Inspections and Tests.

1. *Insulation Tests.*—Insulation tests should be taken periodically with a 500-volt " megger ", and the results should be logged. The insulation resistance will vary with the size and type of installation, and with atmospheric conditions. As a guide, however, the results obtained on an installation for 12 release positions should not be less than those shown on the table. The logging of periodic test results will show any change in the condition of the insulation, and by this means, the development of a fault may be indictaed so that action can be taken to prevent it from becoming serious.

If an earth indicator (Stores Ref. No. 5C/539) is installed on the system, the two lamps inside the fitting should be removed during the insulation tests.

Test No.	*Insulation Tests.*	*Minimum. Result megohms.*
1.	Aircraft installation to " earth " ...	1·0
2.	Aircraft installation between poles ...	1·0
3.	Positive feed to firing bar	2·0
4.	Positive feed to jettison bar	2·0
5.	Jettison bar to firing bar	2·0
6.	Universal carrier to " earth "	10·0
7.	Universal carrier between poles	10·0
8.	L.S. carriers to " earth "	2·0
9.	L.S. carriers between poles	2·0

WT. 31. Disconnect the electrical leads of all bomb carriers at the plug and socket fittings. Disconnect the two feed cables at the source of supply. See that the fuze is fitted in the fuze box. Put on the main switch. Insert the plug, or socket, of the firing switch into the jettison switch fitting. Couple the feed cables together and to the line terminal of the megger, the " earth " terminal being connected to the metal framework of the aircraft. Press down the jettison switch while taking insulation resistance to " earth ". Selector switches to be up or down.

WT. 32. Connect one feed cable to the line terminal and the other to the " earth " terminal of the megger, and press down the jettison switch while taking insulation resistance between poles, selector switches may be up or down.

WT. 33, 34 and 35. The most suitable position for making a connection to the positive feed, firing bar and jettison bar, can be found by reference to the wiring diagram of the installation. The three circuits are always situated in the jettison switch, and this is generally the most suitable position for connecting the megger. Remove the indicating lamp from all jettison switches and take insulation resistance between positive and firing bar, positive and jettison bar. and jettison oar and firing bar, replace indicating lamps.

WT. 36. The insulation resistance of the carrier to " earth " can be taken at the plug by coupling the two pins together and to the line terminal of the megger. The earth terminal is connected to the metal framework of the carrier, and the metal body of the plug should be in contact with the carrier during the test. The release unit may be cocked or uncocked.

WT. 37. Take insulation between the two pins of the two-pin plug, the release unit should be uncocked during this test.

WT. 38. The L.S. carrier is normally fitted with a junction box and a 5-pin plug. Couple all 5 pins together, and test between these and

the metal framework of the carrier and body of plug, as in test WT. 36.

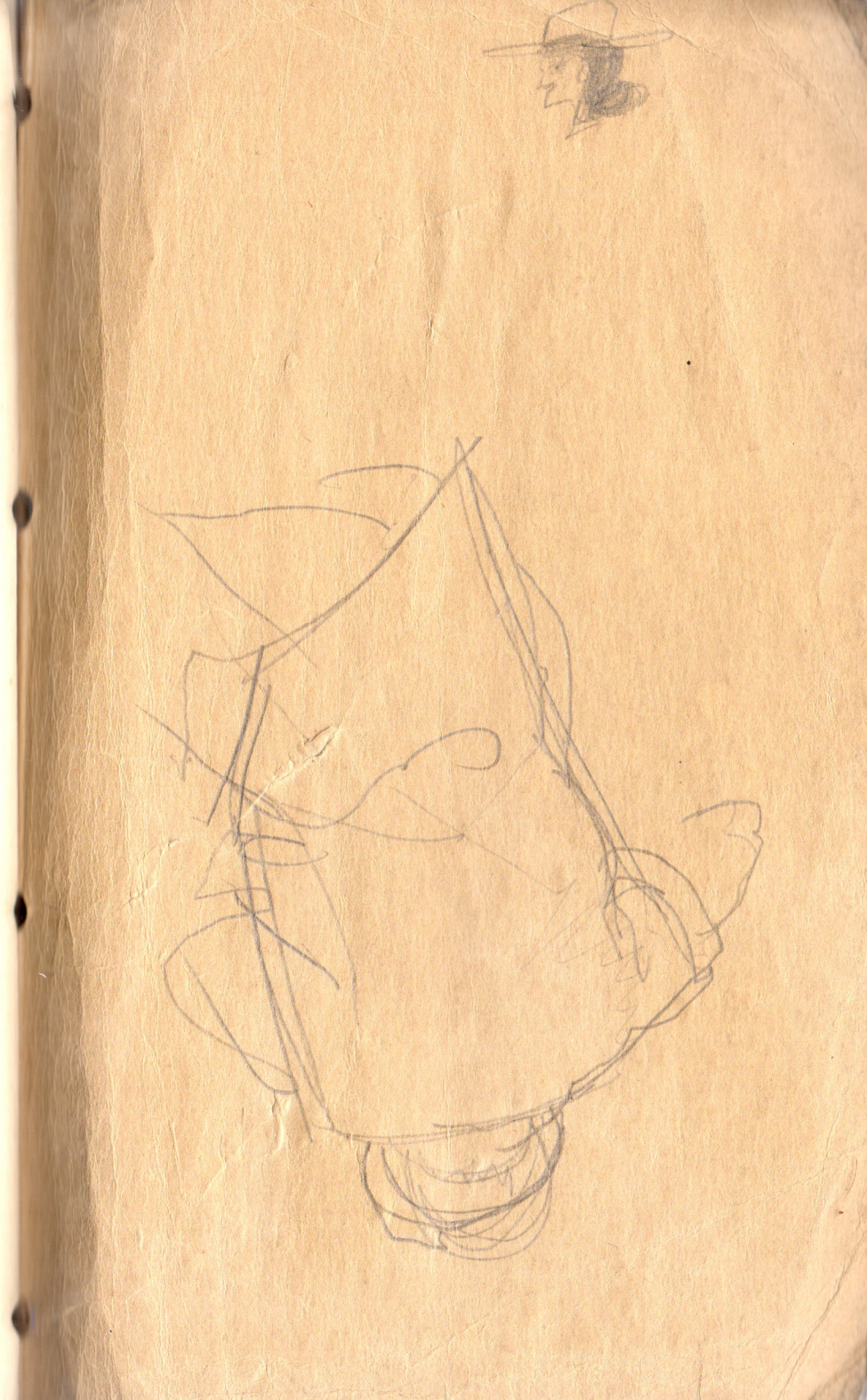
WT. 38. The L.S. carrier is normally fitted with a junction box and a 5-pin plug. Couple all 5 pins together, and test between these and the metal framework of the carrier and body of plug, as in test WT. 36.

WT. 39. At the 5-pin plug, take insulation resistance between red and blue, green and blue, yellow and blue, and white and blue. Release units should be uncocked during these tests.

Tests WT. 36 and WT. 39 must be taken on all carriers before they are connected on the aircraft installation. The tests must be carried out every time the carrier is refitted after a removal for cleaning or other purposes.

2. *Broken Circuits.*—A broken circuit is indicated if the indicating lamp does not operate when the release is cocked—assuming that the indicating lamp is in order, which can be checked by observing the indicating lamp in the second jettison switch fitting by seeing that the installation is properly connected to the 12-volt supply, that the fuze is intact and that the main switch is "*on*".

Any fault indicated by the above tests must be cleared before the installation is used for dropping bombs.



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